Clearwater River

Enhanced Hydraulic Analysis Report

Missoula County, MT

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Michael Baker INTERNATIONAL

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Prepared For:
Montana Department of Natural Resources and Conservation

Prepared By:
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Document History

Document Location

Location

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Clearwater River near Seeley Lake, MT.

Cover Photograph Credit:
Professional Consultants Inc.

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1 Introduction and Background

Under contract to the Montana Department of Natural Resources and Conservation (DNRC), Michael Baker International has completed detailed hydraulic analyses of the Clearwater River in Missoula County, Montana. The purpose of this report is to document the hydraulic analyses and to provide results for subsequent floodplain mapping activities. Results of the analyses will be incorporated into the Missoula County, MT, and Incorporated Areas Digital Flood Insurance Rate Map (DFIRM) and Flood Insurance Study (FIS) (**Reference 1**). **Appendix A** includes the Certification of Compliance form that confirms the study has been completed using sound and accepted engineering practices and is in compliance with all contract documents.

A list of primary flooding sources included in this hydraulic study is provided in **Table 1-1**, and a map showing these flooding sources is provided in **Figure 1-1**. This study represents a revision to the existing floodplain study within the project area and extends from just below Seeley Lake at the upstream study extents to Salmon Lake at the downstream model extents. Effective floodplain mapping near the unincorporated Town of Seeley Lake details the current mapping of the Clearwater River flooding source. The Zone AE mapping along the Clearwater River presented in the effective floodplain mapping is derived from historic FEMA mapping dated August 16, 1988. The existing Clearwater River study is a detailed study with Base Flood Elevations and Floodway and begins approximately 4,600 ft upstream of the Riverview Drive bridge, extending to approximately 450 ft downstream of Placid Creek Road bridge. An area of Approximate (Zone A) mapping exists for approximate 7,500 ft of the Clearwater River below the end of the detailed study reach before Salmon Lake.

The new study documented in this report includes 9.4 miles of one-dimensional (1D) enhanced analyses (with floodway) between Seeley Lake and Salmon Lake (**Figure 1-1**). The hydraulic analysis was completed using peak discharges for the 10-, 4-, 2-, 1-, and 0.2-percent-annual-chance (10-, 25-, 50-, 100-, and 500-year) flood events.

Table 1-1: Flooding Sources Studied

Flooding Source	Upstream Limit	Downstream Limit	Reach Length (Miles)
Clearwater River	1.8 miles Upstream of Riverview Drive Bridge	1.9 miles Downstream of Placid Creek Road	9.4

For this project, multiple contractors and DNRC staff were involved in the delivery of the many components that comprise the Technical Support Data Notebook (TSDN). Professional Consultants Incorporated (PCI) completed the field surveying tasks for the project area (**Reference 2**). The PCI tasks included the collection of cross-section bathymetric survey data and hydraulic structure data.

The topographic data collection (LiDAR) was provided by Watershed Sciences, Inc. (**Reference Error! Reference source not found.**). Montana DNRC Floodplain Engineering staff completed the hydrologic analyses for the study area (**Reference 4**), which was approved as a Conditional Letter of Map Revision (CLOMR) (**Reference 5**). The topographic, field survey, and hydrologic data were reviewed and approved by FEMA, as required, during the associated data capture process. Detailed information regarding PCI, Watershed Sciences, and DNRC contributions to the TSDN are included in the appropriate sections of this report.

1.1 Community Description

Missoula County is located in southwest Montana and is bordered by Mineral County to the west and south; Sanders County to the northwest; Lake and Flathead Counties to the north; Powell County to the east; and Granite and Ravalli Counties to the south. The Town of Seeley Lake is an unincorporated community in Missoula County and is located along the Clearwater River just below Seeley Lake.

Missoula County has experienced significant population growth in the past 19 years. While Seeley Lake's (Seeley Lake CDP) population grew at nearly the same rate as Missoula County between 2000 and 2010, estimates from the American Community Survey (through 2017) indicates a drop in population back to year 2000 levels. It is unknown the reason for the estimated drop in population, but Census 2020 will provide updated population when completed. **Table 1-2** summarizes the Census population data (**Reference 6 through Reference 9**). Note that Seeley Lake data are available through 2017 and Missoula Countywide data are available through 2018. **Table 1-3** summarizes the census housing unit estimates (**Reference 6 through Reference 9**). Again, the Seeley Lake estimates show more than a doubling of housing units between 2000 and 2017. As with population, the Census 2020 will confirm or revise this housing unit estimate.

With the availability of detailed terrain data, hydraulic modeling capabilities, and updated hydrologic data and analysis methods, this study of the Clearwater River will provide the most up to date and state of the practice flood risk information to the community potentially affected by Clearwater River flood flows. This study will help the community understand the potential risks from flooding of living and working near the Clearwater River, as well as the potential flood impacts on the physical assets of the community.

Table 1-2: Census Population Estimates

Community	2000 Population	2010 Population	% Increase from 2000 to 2010	2017[1]/2018[2] Population Estimate	% Increase from 2010 to 2017[1]/2018[2]
Seeley Lake	1,436	1,659	15.5%	1,441[1]	0.0%
Missoula County	95,802	109,299	14.1%	118,791[2]	24.0%

Table 1-3: Census Housing Units Estimates

Community	2000 Housing Units	2010 Housing Units	% Increase from 2000 to 2010	2017[1]/2018[2] Housing Units Estimate	% Increase from 2010 to 2017[1]/2018[2]
Seeley Lake	938	1,262	34.5%	1,984[1]	211.5%
Missoula County	41,319	50,106	21.3%	54,926[2]	32.9%

Most severe flooding events in the Clearwater River watershed (HUC 8 17010203) have been the result of spring and early summer snowmelt and/or rainfall. Historically, notable flooding within this watershed has occurred numerous times.

Above the study area, there are several small lakes that the Clearwater River flows through before reaching the study area. In order from upstream to downstream, the Clearwater River flows through: Rainy Lake, Lake Alva, Lake Inez, and Seeley Lake, which is immediately above the study area. There are no USGS gaging stations on the Clearwater River within the study area, however there is a USGS gage located on the Clearwater River about 10 miles below the study area (USGS 12339450 Clearwater River near Clearwater, MT) which collected data from 1975 – 1992 and 1997. Using data derived from this gaging station, DNRC performed an updated hydrologic analysis using Basin Characteristic regression estimates (upstream of the Morrell Creek confluence) and Basin Area-weighted Gage Transfer estimates (below Morrell Creek confluence and downstream of the Owl Creek confluence) for the study reach (**Reference 4**). The gaging station indicates all peak flow events occurred in either April or May and ranged from 2,030 cfs (1982) to 3,800 cfs (1997) at the gaging station. Stream gage locations and watershed delineations are provided in **Appendix D**.

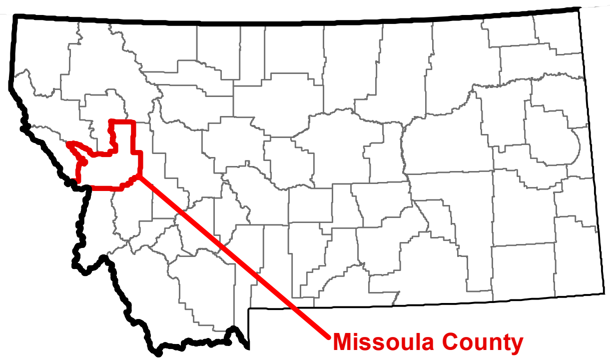
Legend

- Clearwater River
- Seeley Lake
- County Boundary

Figure 1-1: Project Area - Clearwater River

0 0.5 1 Miles

DATA FRAME PROPERTIES:
Coordinate System: NAD 1983 2011 StatePlane Montana FIPS 2500 Ft Int
Projection: Lambert Conformal Conic
Datum: NAD 1983 2011
Vertical Datum: NAVD 88
Units: Feet



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1.2 Basin Description

The Clearwater River, located in the northeastern corner of Missoula County, originates in the Mission Mountain Range and flows south, southeasterly for approximately 50 miles before its confluence with the Blackfoot River. At its mouth, the river drains a watershed area of approximately 390 square miles. The Clearwater River is fed by steep mountain streams from the Mission Mountain range on the west and the Swan Mountain Range on the east which converge at the valley floor. The river flows through several lakes, and the study reach gradient is approximately 10.5 feet per mile, or 0.002 foot per foot (**Reference 1**).

Although the study area consists mainly of forest and pasture land, the Clearwater Valley is a popular summer recreation area due to the numerous lakes in the area. The agricultural land use is limited to hay crops.

1.3 Previous Studies

The study reach is currently mapped by FEMA. The areas studied by enhanced methods were prioritized by identifying known flood hazard areas and areas projected for development at the time. The currently mapped reach studied by enhanced methods of the Clearwater River extends from approximately 450 feet below the Placid Creek Road bridge upstream approximately 8 miles to a point 4,600 feet above the Riverview Drive bridge.

Water-surface profiles for the Clearwater River were completed using the US Army Corps of Engineers (USACE) HEC-2 software and date back to 1977. It is unknown who performed the study. Field data was collected for cross section data used in the hydraulic model. According to the FIS, the starting water-surface elevations were determined from a rating curve developed from field measurements of cross sections near the start of the study. The approximate streambed slope between measured sections was used. Manning's "n" values, estimated by field inspection, used in the study range from 0.033 - 0.038 for the channel and 0.038 - 0.095 in the overbanks.

The effective Flood Insurance Rate Maps (FIRM) display data was converted to a digital format. The Special Flood Hazard Area (SFHA) for this reach consists of Zone AE, 1% annual chance (AC) with base flood elevations determined, a floodway delineated within the Zone AE areas, as well as Zone X, 0.2% AC inundation areas. The currently mapped segment studied by approximate methods extends from the Placid Creek road bridge approximately 1.4 miles downstream and consists of Zone A, where no base flood elevations were determined. **Table 1-4** lists the discharge values for the recurrence interval flows in the effective FIS report.

This new study has been completed to update the antiquated hydraulic model and mapping with the most recent USACE hydraulic modeling software (HEC-RAS 5.0.7), better topographic data, survey data, and the most recent standards and guidance from FEMA.

Table 1-4: Currently Effective Peak Flows

Location	Drainage Area (mi^2)	Discharges (cfs)			
		10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Above Morrell Creek	140	2,340	2,940	3,170	3,650
At downstream detailed study limit	220	3,040	3,840	4,180	4,860

2 Hydrologic Analysis

In advance of this hydraulic analysis, a hydrologic analysis was completed for this reach of the Clearwater River. The hydrology study included a stream gage analysis based on USGS gage 12339450 Clearwater River near Clearwater, MT as well as a regional regression analysis (**Reference 4**). The study concluded that separate recurrence interval discharges are recommended for the reaches upstream of the Morrell Creek confluence, upstream of the Owl Creek confluence, and downstream of the Owl Creek confluence. Discharges upstream of the Morrell Creek confluence were calculated using Basin Characteristics regional regression equations, while discharges upstream and downstream of the Owl Creek confluence reflect transfer of the Systematic (weighted with Basin Characteristics regression) discharges estimated at the gaging station. The selected discharges are summarized in **Table 2-1**.

Table 2-1: Updated Discharges Used in Hydraulic Analyses

Flooding Source and Location	Peak Discharges (cfs)				
	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2 % Annual Chance
Upstream of Morrell Creek Confluence (RS 50,541)	1,630	1,940	2,200	2,460	3,010
Upstream of Owl Creek Confluence (RS 22,266)	1,840	2,280	2,620	2,990	3,890
Downstream of Owl Creek Confluence (RS 10,866)	2,440	2,990	3,440	3,900	5,040

3 Hydraulic Analysis

3.1 Methodology and Hydraulic Model Setup

The new enhanced study begins just upstream of Salmon Lake and extends upstream 9.4 miles, terminating downstream of the Boy Scout Road bridge near the river headwaters at Seeley Lake. This study will replace the current effective floodplain mapping on the Clearwater River.

One-dimensional steady flow hydraulic analysis methods were utilized for the study using HEC-RAS Version 5.0.7 (**References 10 and 11**) operating within CivilGEO Engineering's modeling software, GeoHECRAS, Version 2.7 (**Reference 12**) to perform step-backwater calculations for subcritical flow conditions. GeoHECRAS is an AutoCAD and ESRI ArcGIS compatible interactive 2D/3D graphical interface data wrapper to the US Army Corps of Engineers HEC-RAS. Modeling and analysis were completed in accordance with the most recent FEMA Standards for Flood Risk Projects (**References 13 and 14**) and related guidance documents. The reach was studied by enhanced methods and includes a floodway encroachment analysis. The model was developed in reference to the NAVD88 vertical datum.

3.2 Field Survey and Topographic Information

Field survey and topographic information were collected using the methods and procedures outlined in FEMA's Guidelines and Specifications for Flood Risk Analysis and Mapping. Specifically, FEMA's Data Capture Technical Reference (**Reference 15**), Guidance for Flood Risk Analysis and Mapping Data Capture - General (**Reference 13**), and Guidance for Flood Risk Analysis and Mapping Data Capture – Workflow Details (**Reference 14**) were adhered to.

3.2.1 LiDAR Collection

Watershed Sciences, Inc. (WSI) acquired topographic Light Detection and Ranging (LiDAR) data for the project area on October 31, 2012. LiDAR deliverables included:

- LAS files;
- Raster Grid files and GeoTiffs;
- Shapefiles including site boundary, LiDAR Index, DEM Index, 2-foot Contours, RTK Checkpoints, and Landcover Checkpoints;
- AutoCAD drawing files (.dwg files) including 2-foot contours; and
- Data summary report. (**Reference 3**)

The DEM served as the primary topographic surface for the project and was used to develop the cross sections using GeoHECRAS.

3.2.2 Field Survey Collection

The field survey for the Clearwater River study was completed by PCI, Inc. in October 2014. The data was collected as listed below.

Table 3-1 Field Survey Collection Summary

Flooding Source	Number of Hydraulic Structures	Number of Cross Sections
Clearwater River	4	31

In addition to measurements of the structure dimensions during the field survey, photographs of the structures and stream channel were part of the survey data collect (**Appendix E**). The bridge data was utilized to build the structures in the HEC-RAS model. Additionally, for the purpose of defining the stream channel capacity, PCI, Inc. surveyed 31 bathymetric cross sections throughout the study reach.

3.3 Flow Areas

This study involves 1D analyses within the study area to best describe and represent the flood risks in these areas. 1D study methods were utilized throughout study reach and for encroachment analyses to establish the regulatory floodway.

3.4 Profile Baseline

The stream channel centerline of the Clearwater River was used to define the Profile Baseline, and River Stationing (RS) was established as “Stream distance in feet above Salmon Lake”. With the downstream study limits defined (at RS 1038), the profile baseline was delineated along the Clearwater River stream channel by referencing: the aerial imagery and the 2-foot contour data.

Table 3-2 Summary of Station References

Flooding Source	Station Reference
Clearwater River	Feet above limit of study (Confluence with Salmon Lake)

3.5 Boundary Conditions

The HEC-RAS model was executed under the assumption of subcritical flow. The “normal depth” option was selected as the downstream boundary condition used to compute the starting water surface elevations. The channel/water surface slope in the vicinity of the downstream study limit was determined based on the assumption that the slope of the downstream end of the study reach is representative of the controlling slope downstream of the study reach. The slope selected for normal depth boundary condition is listed below:

Clearwater River: Main Channel Slope = 0.00092 ft/ft

There are two flow changes within the study reach, at the Morrell Creek and Owl Creek confluences. A summary of discharges for the study reaches is provided in **Reference 4**.

3.6 Manning's Roughness Coefficients

Manning's n values for the Clearwater River floodplain were assigned considering a combination of: field reconnaissance observations; aerial imagery evaluation; established hydraulic modeling guidelines (**References 16 and 17**); experience, and professional judgment.

The ranges of values selected are listed below:

Main Channel	Overbank Area
0.038	0.04 – 0.13

The overbank along the Clearwater River varies in roughness, but the study reach can be broken into three separate reaches that share similar vegetative characteristics:

- Upper Reach – above the Riverview Drive Bridge;
- Middle Reach – from the Riverview Drive Bridge downstream to the Morrell Creek confluence;
- Lower Reach – downstream of the Morrell Creek confluence.

The Upper Reach is essentially an extension of Seeley Lake with significant residential development on both sides of the channel. Boat docks are common throughout this reach, and residential lawns extend to the edge of the channel. The vegetation immediately adjacent to the channel is composed primarily of light grasses although there is some roughness associated with the boat docks. Beyond the immediate buffer of light grasses along the channel, forested areas with light underbrush and residential structures are common to the lateral extents of the floodplain.

The Middle Reach also passes through reaches of residential development. The overbank vegetation ranges from light grasses in low-lying floodplain to open fields to forested areas with light underbrush to areas of thick riparian vegetation. In general, the east side of the channel has more residential development and a wider floodplain than the west side of the channel through this reach.

The Lower Reach of the study has thicker riparian vegetation along the channel, especially downstream of the Placid Creek Road Bridge. Beyond the typical riparian vegetation, this reach is composed of thicker forested areas. The upper end of this reach has some residential development on the east side of the channel.

3.7 Development of Cross-Sectional Geometries

The LiDAR based DEM (NAVD88 vertical datum) was utilized as the three-dimensional surface from which cross sections were created (or "cut") using GeoHECRAS and extracted into the HEC-RAS hydraulic models. GeoHECRAS was also used to generate the profile baseline, overbank flow paths, and structure/roadway sections with the DEM. Bank stations were selected manually in HEC-RAS concurrent with the assignment of roughness coefficients. Cross sections were aligned perpendicular to the direction of flood flow and extended to sufficiently capture the 0.2 percent-annual-chance discharge boundaries. Intermediate cross sections (those between structure cross sections) were spaced at distances less than one thousand feet per FEMA guidelines (for detailed study reaches) and appropriately located at points where hydraulic characteristics (such as channel slope, roughness, etc.) change abruptly. Cross Sections are shown on the Floodplain Work Maps in **Appendix B**. Where field survey data was collected for channel bathymetry and the structure surveys at each stream crossing (including 4 cross sections – two above and two below the structure), the data was merged with the DEM (LiDAR generated) hydraulic model cross sections. Additional cross sections were "cut" from the DEM between the surveyed sections. To approximate the channel bathymetry for these intermediate cross sections, the channel thalweg was interpolated and the channel area was sized to approximately match the channel upstream and downstream.

The four typical structure cross sections (#1 – 4 per HEC-RAS/USACE standard labeling) were placed at each stream crossing and are discussed further in the following section. The automated cross section interpolation procedure in HEC-RAS was not used to generate any cross sections throughout the model. Additional details of the main channel cross sections are presented below:

<u>Main Channel Cross Sections</u>

The Clearwater River channel hydraulic model consists of 123 cross sections along the study reach length of 49,503 feet (9.38 miles), with the first cross section at RS 1038 and the last cross section at RS 50541. Average cross section spacing is 445 feet for the reach, while the maximum spacing is 3209 feet downstream of RS 7346.

3.8 Hydraulic Structures

Field survey data, along with field measurements of structure dimensions, were used to generate the structure geometry in the hydraulic model for the four stream crossings. The four typical bridge/culvert structure cross sections (XS 1 - 4 per HEC-RAS/USACE standard labeling) were placed and aligned manually using GeoHECRAS, then cut from the DEM, and imported into the HEC-RAS model along with the other intermediate cross sections. The locations were selected considering: HEC-RAS model guidelines; location of field surveyed cross sections; and the unique physical and geometric characteristics of each crossing. As described above, field survey data was used to replace the channel portion of the DEM "cut" cross sections. Contraction and expansion coefficients were set to 0.3 and 0.5 respectively, at structure model cross sections 2, 3, and 4 (per HEC-RAS/USACE standard labeling). Ineffective flow areas were defined for the bounding bridge cross sections at all four stream crossings. Locations were set considering HEC-RAS modeling guidelines (**Reference 10**) for bridges (1:1 contraction and 2:1 expansion). Specifics relating to the selected assignments at each stream crossing are discussed below.

3.8.1 Clearwater River Structures

Four stream crossings, each consisting of bridge structures, are located along the Clearwater River study reach. Field survey notes and survey points in AutoCAD were used to construct the bridge structures in HEC-RAS. The crossings are described below, beginning at the downstream most structure:

Table 3-3 Summary of Bridge Structures

Bridge ID	River Station	Number of Spans	Total Span (ft)	Deck Width (ft)	Pier Width (ft)	Pier shape	Pier Coefficient (Cd)	Low Flow Method	High Flow Method
Placid Creek Road Bridge	12142	1	61.0	25.4	-	-	-	Energy, Momentum	Energy
Wagon Wheel Way Bridge	32091	5	77.9	14.9	1.2	Circular	1.2	Energy, Momentum	Energy

W. Wagon Wheel Ct. Bridge	34165	1	83.2	10.2	-	-	-	Energy, Momentum	Energy
Riverview Drive	40757	5	100.8	14.9	2.33	Square nose	2	Energy, Momentum	Energy

<u>Crossing 1 – Placid Creek Road Bridge, RS 12142</u>

This two-lane, single-span bridge is composed of a timber superstructure, timber wingwalls, and an asphalt paved deck. The superstructure is supported by wooden vertical abutments, and the w-beam guardrail is supported by wooden posts fastened to the superstructure. Channel cross sections surveyed above and below the bridge were merged with the DEM cut cross sections at structure sections 1-4 (RS 12040, 12096, 12187, and 12225, respectively).

Ineffective flow stations were assigned at the bounding cross sections (XS2-RS 12096 and XS3-RS 12187), and the ineffective flow limits were determined to extend downstream and upstream into cross sections 11906 and 12607 following preliminary analysis. Ineffective flow limits were developed considering the standard 1:1 contraction and 2:1 expansion method and incorporated physical high ground features. Additional ineffective flow assignments were made considering the overtopping flow configuration and topography. The Manning's n channel value of 0.038 was perpetuated through the bridge opening.

The capacity of the 60-foot wide bridge opening exceeds the 100-year flood event. However, at the 500-year event, while the bridge does not become submerged, some water (~200 cfs) does overtop the roadway to the right of the bridge opening. For the purpose of maintaining accurate flow distribution across the four structure cross sections, the ineffective flow limits in the right overbank were set to "permanent" in cross sections 1-4; using the "non-permanent" setting for these ineffective flow areas results in excessive effective conveyance upstream and downstream of the roadway in the right overbank. The Pressure/Weir method was selected for the High Flow modeling approach.

Figure 3-1 Placid Creek Road Bridge

Crossing 2 – Wagon Wheel Way Bridge, RS 32091

This single-lane timber bridge has asphalt surfacing and is supported by wooden vertical abutments and four wooden piers. Each pier consists of three, 14-inch diameter timber posts. As a safety feature, square timber rails extend the length of the bridge on both the upstream and downstream sides.

Channel cross sections surveyed above and below the bridge were merged with the DEM cut cross sections at structure sections 1-4 (RS 32023, 32053, 32131, and 32190, respectively). Ineffective flow stations were assigned at the bounding cross sections (XS2-RS 32053 and XS3-RS 32131), and the ineffective flow limits were determined to extend downstream and into cross section 31987 and upstream and into cross section 32190, following preliminary analysis. They were developed considering the standard 1:1 contraction and 2:1 expansion method and incorporated physical high ground features. The Manning's n channel value of 0.038 was perpetuated through the bridge opening.

The capacity of the Wagon Wheel Way Bridge is greater than the 500-year event, and there is greater than one foot of freeboard at the 500-year event. As a constriction, the bridge does create a backwater effect upstream of the bridge extending approximately 500 feet to RS 32617.

Figure 3-2 Wagon Wheel Way Bridge

<u>Crossing 3 – Wagon Wheel Court Bridge, RS 34165</u>

The Wagon Wheel Court Bridge is a single-lane, single-span bridge made from a flatbed railroad car. Vertical wooden abutments provide support at the ends of the structure and have wooden wingwalls connected on both the upstream and downstream sides. There are no safety features (guardrail, curbing, etc.) present at this structure.

Channel cross sections surveyed above and below the bridge were merged with the DEM cut cross sections at structure sections 1-4 (RS 34123, 34142, 34187, and 34228, respectively). Ineffective flow stations were assigned at the bounding cross sections (XS2-RS 34142 and XS3-RS 34187). They were developed considering the standard 1:1 contraction and 2:1 expansion method and incorporated physical high ground features. The Manning's n channel value of 0.038 was perpetuated through the bridge opening.

The capacity of the Wagon Wheel Court Bridge is greater than the 500-year event, and there is greater than two feet of freeboard at the 500-year event. As a constriction, the bridge does create a slight backwater effect upstream of the bridge extending approximately 100 feet to RS 34271. The bridge does not overtop, the backwater affects are due to reduced conveyance as a result of the of the roadway fill in the floodplain.

Figure 3-3 West Wagon Wheel Court Bridge

Crossing 4 – Riverview Drive Bridge, RS 40757

The Riverview Drive Bridge is a single-lane structure with a superstructure composed of steel I-beams and decking composed of timber planks. The horizontal I-beam superstructure is supported by six piers constructed from a configuration of various sized steel I-beams. The bridge extends on the upstream side of the driving lane with a pedestrian walkway and handrail; the downstream side of the structure is protected by a w-beam guardrail supported by wooden posts.

Channel cross sections surveyed above and below the bridge were merged with the DEM cut cross sections at structure sections 1-4 (RS 40682, 40727, 40798, and 40830, respectively). Ineffective flow stations were assigned at the bounding cross sections (XS2-RS 40727 and XS3-RS 40798. Ineffective flow limits were developed considering the standard 1:1 contraction and 2:1 expansion method and incorporated physical high ground features. The Manning's n channel value of 0.038 was perpetuated through the bridge opening.

The capacity of the Riverview Drive Bridge is greater than the 500-year event, and there is approximately three feet of freeboard at the 500-year event. The elevation of the channel bottom within the bridge opening is significantly greater (greater than 3') than the elevation of the channel bottom at the cross section immediately downstream of the crossing as well as all of the sections upstream of the bridge crossing. This feature essentially functions as a weir and is the hydraulic control for the water surface upstream of the bridge; this results in a relatively uniform water surface elevation from the bridge to the upstream extents of the study reach.

Figure 3-4 Riverview Drive Bridge, downstream

3.9 Non-Conveyance/Blocked Obstruction Areas

Ineffective areas and blocked obstructions were used in the model to restrict flows to areas of cross sections capable of actively conveying flow. Ineffective flow areas were used to model several different hydraulic scenarios:

1. In the vicinity of hydraulic structures, ineffective areas are used in areas that would not actively convey flow due to being blocked by the abutments or the approach to the structure itself. These ineffective areas were placed in accordance with structure modeling guidance provided in the HEC-RAS Hydraulic Reference Manual.

2. For hydraulically disconnected regions, ineffective areas were added to the model to account for the fact that flow would not be actively conveyed in these areas.

3. In overbank areas where flow during flooding events would be minor or insignificant, ineffective areas were used to ensure that accurate hydraulic calculations were taking place in the active, more significant flow paths. This type of area tended to be a location where flow would not significantly penetrate, such as locations where flow to the lower overbank areas would be mostly blocked by high ground or an embankment near to the bank station.

4. Areas where the flow would be predominately lateral to the primary direction of flow were modeled as ineffective flow areas. One example of this would be at a cross section where a lateral incoming ditch was picked up along the cross section from the terrain data. These areas of lateral flow would not convey flow effectively in the primary flow direction during a flooding event.

Montana Highway 83 is located within the study area and represents a non-certified, levee-like feature on the east side of the Clearwater River floodplain. Highway 83 limits conveyance on the landward side of the levee-like feature. However, since the highway is not a certified levee, the areas on the landward side of the highway were treated as ineffective flow areas and any areas with inundation were included in the floodplain mapping workmaps.

3.10 Model Results and Mapping

ESRI ArcMap GIS software (**Reference 18**) was used to generate the 'rough cut' floodplain mapping spatial files for the Clearwater River. Shapefile products developed include the profile baseline/stream centerline, HEC-RAS model cross sections (lettered and unlettered), BFE lines, structures, floodway encroachment stations, and the rough-cut 1-, and 0.2 percent-annual-chance floodplain boundaries. The HEC-GeoRAS interface program was used to transfer the hydraulic model results to ArcMap and generate approximate inundation areas. These areas were used to develop the final floodplain boundaries by referencing the 2-foot contour data. Floodway and floodplain boundaries were adjusted as needed to match the hydraulic model results within acceptable limits. A Floodplain Work Map was developed and is included in **Appendix B**. High ground "island" areas of non-flooding within the floodplain and less than one acre in size were removed. This may cause mapped top width distances along cross sections to exceed the allowable error when compared to the values of the hydraulic models.

- High ground islands were removed from the 1 percent-annual-chance floodplain at River Stations: 38990, 40099, 41066, 41643, and 42465
- High ground islands were removed from the Floodway at River Stations: 40099
- High ground islands were removed from the 0.2 percent-annual-chance floodplain at River Stations: None

Floodplain Work Maps have been prepared in accordance with recently released (Draft) DNRC Guidance for Work Maps. The models appear to produce reasonable results throughout the study reach. The resultant floodplains were exported from the model and smoothed and minimally refined using automated processes. Work maps containing these "raw" floodplain results are included for informational benefit in **Appendix B**. We anticipate that we will manually refine the mapping further, to create a product suitable for mapping of the appropriate floodplain Zone designations, during the next phase of this project.

3.11 Letter of Map Revision and Existing Study Data Incorporation

No LOMRs or any other existing studies were included in this analysis.

3.12 Multiple/Worst Case Scenario Analysis

Reviews of the effective FIRM panels, survey data, and terrain data showed that there are no FEMA accredited levees in the study area. No significant flow structures were identified within the study reach of the Clearwater River that have the ability to significantly alter the flow distribution within the Clearwater River mainstem. As described in Section 3.9, Montana Highway 83 is located in the eastern extent of the Clearwater River floodplain in the lower portion of the study limits. However, the highway does not significantly impact conveyance and Base Flood Elevations and scenario analyses are not warranted for this feature. The hydraulic work maps include floodplain delineation in areas where inundation would occur in the absence of the highway. Thus, neither multiple nor worst case scenario analyses were required.

3.13 Floodway Analysis

A floodway analysis was performed for the study area. The main channel of Clearwater River contains all the flow for the floodway. Floodway for the Clearwater River was determined using the equal conveyance reduction method. Per state of Montana guidelines, the maximum allowable surcharge at any given cross section is 0.50 feet. The floodway encroachment stations were revised until this requirement was met.

Several notes on the equal conveyance reduction floodways:

- The encroachment stations are set using the HEC-RAS hydraulic modeling program, encroaching on the overbanks on each side of the channel by reducing the conveyance equally on both sides until the target surcharge (0.50 feet) is met.
- When HEC-RAS sets the encroachment stations after the first floodway modeling run, there are frequently surcharges greater than the maximum allowable at many cross sections. The target surcharge is lowered on a cross section-by-cross section basis until the maximum allowable surcharge is not exceeded at any cross section.
- It is generally not possible for the surcharge to be exactly 0.50 feet at all locations. The surcharge is brought as close to the maximum allowable height at each cross section without going over.
- Negative surcharges are occasionally calculated in HEC-RAS. Efforts were made to change the encroachment stationing to remove the negative surcharges.
- At some areas where cross sections are close together, the equal conveyance reduction method produces a floodway that is unreasonable due to inconsistent floodway widths between cross sections. The floodway is smoothed by manually moving encroachment stations in the model.
- Because the encroachments are not allowed into the channels of flooding sources, floodways sometimes appear to be unbalanced. However, this is appropriate: if the channel is on the far-left side of the floodplain, for example, the left side cannot be further encroached, and all encroaching is done on the right side of the floodplain.

4 Flood Insurance Study

FEMA's KSS (**Reference 19**), Technical Reference: FIS Report (**Reference 20**), and Guidance for Flood Risk Analysis and Mapping: Flood Insurance Study Report (**Reference 21**) were followed to create the products in this section of the report. The FIS components included in **Sections 4.1, 4.2, and 4.3** were created using FEMA's latest format specifications.

4.1 FIS Text

The relevant FIS tables have been populated with data from this study. The FIS information is in **Appendix H**.

4.2 Floodway Data Tables

The Floodway Data Tables are in **Appendix I** of this report. Footnotes have been added where appropriate to denote cross sections where special considerations cause differences between the information reported in the Floodway Data Tables, the HEC-RAS model, or the Hydraulic Work Maps.

4.3 Water Surface Elevation Profiles

The water surface elevation profiles depict the 10-, 4-, 2-, 1-, and 0.2-percent annual chance flood events are included in **Appendix J** of this report.

5 References

1. Federal Emergency Management Agency, Flood Insurance Study, Missoula County and Incorporated Areas, March 7, 2019.

2. Professional Consultants Inc., Clearwater River (Missoula County) Survey Methodology Report. October 29, 2014.

3. Watershed Sciences Inc., 2-foot contours – derived from ground-classified LiDAR point data (collected Oct. 2012), Missoula County, Montana 2013.

4. Montana Department of Natural Resources and Conservation, Hydrology Design Report Clearwater River Detailed Floodplain Study Missoula, MT, February 2017.

5. Federal Emergency Management Agency, Conditional Letter of Map Revision for Clearwater River Hydrology, Missoula County, MT. May 1, 2017.

6. US Census Bureau, Montana: 2000 Summary Population and Housing Characteristics 2000 Census of Population and Housing, US Department of Commerce, September 2002.

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8. Census Quickfacts, US Census Bureau. Missoula County, Montana https://www.census.gov/quickfacts/fact/table/missoulacountymontana,US/PST045219. Accessed January 8, 2020.

9. American Fact Finder, United States Census Bureau. Town of Seeley Lake, Missoula County, Montana. https://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml. Accessed January 8, 2020.

10. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-RAS River Analysis System, Version 5.0, User's Manual. Davis, CA, February 2016.

11. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-RAS River Analysis System, Supplemental to HEC-RAS Version 5.0 User's Manual. Version 5.0.4. Davis, CA. April 2018.

12. GeoHECRAS. CivilGeo. Middleton, WI, 2019; software available at www.civilgeo.com

13. Federal Emergency Management Agency, Guidance for Flood Risk Analysis and Mapping Data Capture - General, February 2018.

14. Federal Emergency Management Agency, Guidance for Flood Risk Analysis and Mapping Data Capture – Workflow Details, February 2018.

15. Federal Emergency Management Agency, Data Capture Technical Reference, February 2018.

16. Barnes, Harry H. Jr., 1967, Roughness Characteristics of Natural Channels, U.S. Geological Survey Water-Supply Paper 1849, Washington, 213 p.

17. Chow, Ven Te, 1959, Open Channel Hydraulics, McGraw-Hill Book Company, Inc., New York. Environmental Systems Research Institute, Inc. (ESRI), ArcMap with Spatial Analyst and 3D Analyst, Version 10.6, Service Pack 1, 2019

18. Environmental Systems Research Institute, Inc. (ESRI), ArcMap with Spatial Analyst and 3D Analyst, Version 10, Service Pack 1, 2010.

19. Federal Emergency Management Agency, Knowledge Sharing Site.

20. Federal Emergency Management Agency, Guidance: Flood Insurance Study (FIS) Report, November 2016.

21. Federal Emergency Management Agency, Technical Reference: Flood Insurance Study (FIS), February 2018.

Appendix A
Certification of Compliance

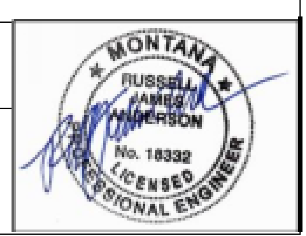
Appendix A: Certification of Compliance

CERTIFICATION OF COMPLIANCE	
Project Name:	Clearwater River PMR
Statement of Work No:	WO-MB-202
Statement/Agreement Date:	November 14, 2019
Certification Date:	February 21, 2020

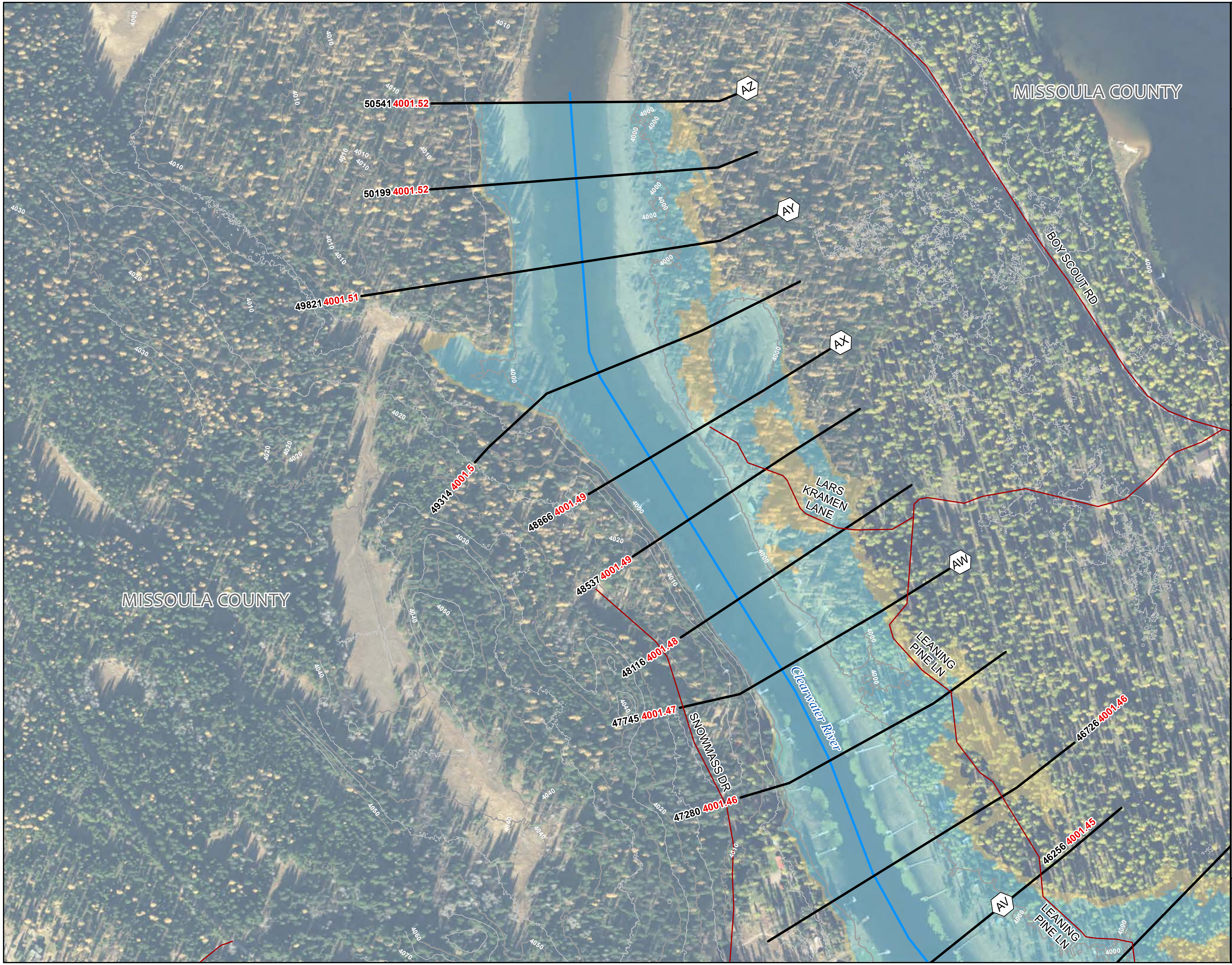
Tasks/Activities Covered by This Certification (Check All That Apply)	
☐	Entire Project
☐	Topographic Data Development
☐	Hydrologic Analyses
☒	Hydraulic Analyses
☐	Coastal Flood Hazard Analyses
☐	Floodplain Mapping
☐	Other (Specify): Base Map

This is to certify that the work summarized above was completed in accordance with the statement/agreement cited above and all amendments thereto, together with all such modifications, either written or oral, as the Regional Project Officer and/or Assistance Officer or their representative have directed, as such modifications affect the statement/agreement, and that all such work has been accomplished in accordance with the provisions contained in *Guidelines and Specifications for Flood Hazard Mapping Partners* cited in the contract document, and in accordance with sound and accepted engineering practices within the contract provisions for respective phases of the work.

Name:	Russell J. Anderson
Title:	Project Manager
Firm/Agency Represented:	Michael Baker International
Registration No:	MT P.E. 18332
Signature:	



Appendix B
Hydraulic Work Maps



CLEARWATER RIVER HYDRAULIC WORKMAP

February 20, 2020

LEGEND

- Study Profile Baseline
- Proposed 1-Percent-Annual Chance Event
- Proposed 0.2-Percent-Annual Chance Event
- Proposed Cross Section
- 10 FT Contour
- 5 FT Contour
- Interstate, US, State, or County Highway
- All Other Roads
- Political Area

Labels

5242.18 Water Surface Elevation

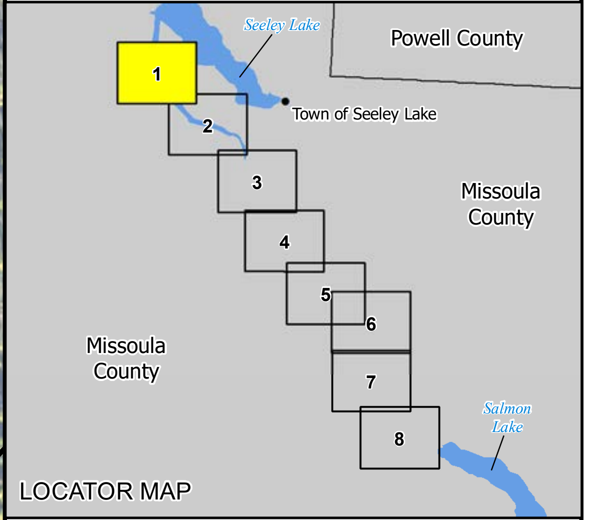
A Cross Section Letter 94889 River Station

0 100 200 300 400 Feet

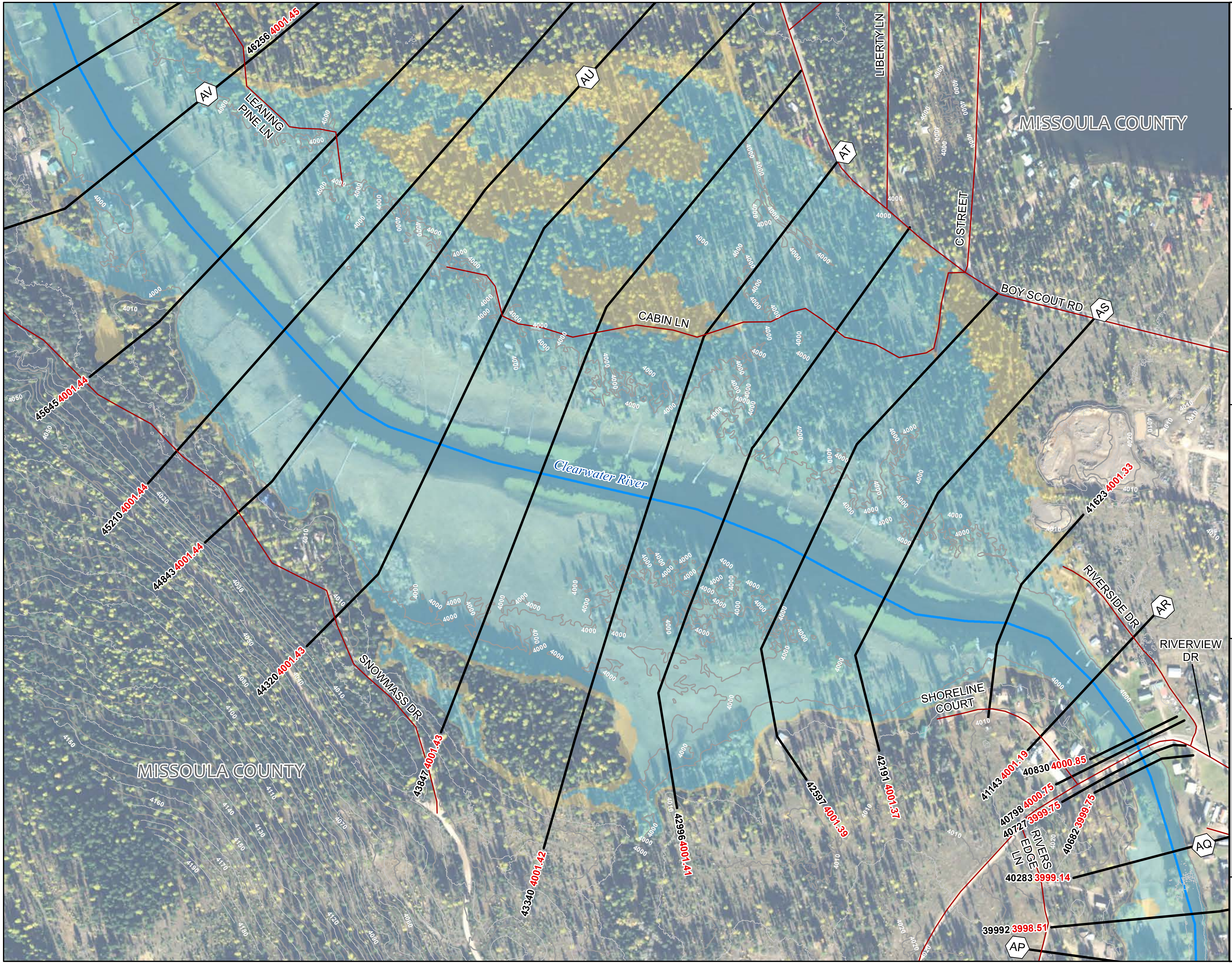
1 inch = 400 feet

DATA FRAME PROPERTIES:
Coordinate System: NAD 1983 2011 StatePlane Montana FIPS 2500 Ft Intl
Projection: Lambert Conformal Conic
Datum: NAD 1983 2011
Vertical Datum: NAVD 88
Units: Feet

Michael Baker INTERNATIONAL
165 S. UNION BLVD.
SUITE 1000
LAKEWOOD, CO 80228
PHONE: 720-514-1100



Clearwater River Map 1 of 8



CLEARWATER RIVER HYDRAULIC WORKMAP

February 20, 2020

LEGEND

- Study Profile Baseline
- Proposed 1-Percent-Annual Chance Event
- Proposed 0.2-Percent-Annual Chance Event
- Proposed Cross Section
- 10 FT Contour
- 5 FT Contour
- Interstate, US, State, or County Highway
- All Other Roads
- Political Area

Labels

5242.18 Water Surface Elevation

A Cross Section Letter 94889 River Station

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DATA FRAME PROPERTIES:

Coordinate System: NAD 1983 2011 StatePlane Montana FIPS 2500 Ft Int
Projection: Lambert Conformal Conic
Datum: NAD 1983 2011
Vertical Datum: NAVD 88
Units: Feet

Michael Baker INTERNATIONAL

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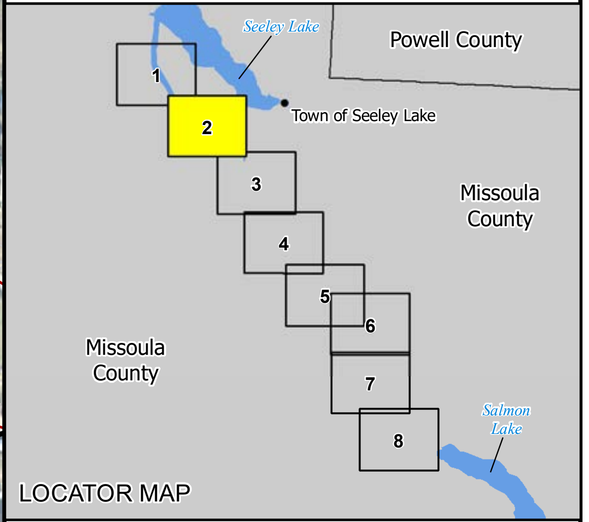
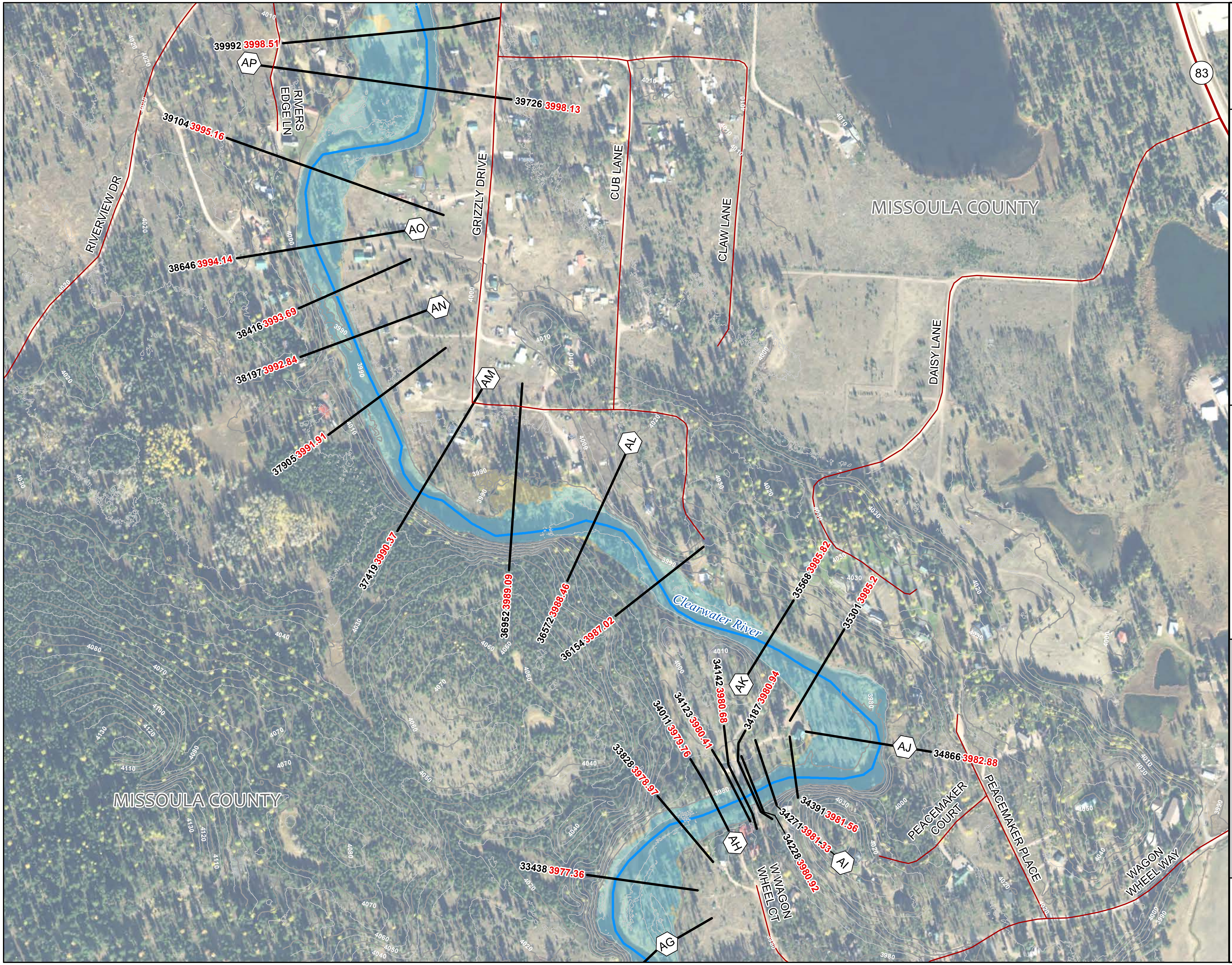


Clearwater River Map 2 of 8

CLEARWATER RIVER HYDRAULIC WORKMAP

February 20, 2020



LEGEND

- Study Profile Baseline
- Proposed 1-Percent-Annual Chance Event
- Proposed 0.2-Percent-Annual Chance Event
- Proposed Cross Section
- 10 FT Contour
- 5 FT Contour
- Interstate, US, State, or County Highway
- All Other Roads
- Political Area

Labels

5242.18 Water Surface Elevation

A Cross Section Letter

94889 River Station

0 100 200 300 400 Feet

1 inch = 400 feet

DATA FRAME PROPERTIES:

Coordinate System: NAD 1983 2011 StatePlane Montana FIPS 2500 Ft Int
Projection: Lambert Conformal Conic
Datum: NAD 1983 2011
Vertical Datum: NAVD 88
Units: Feet

Michael Baker INTERNATIONAL

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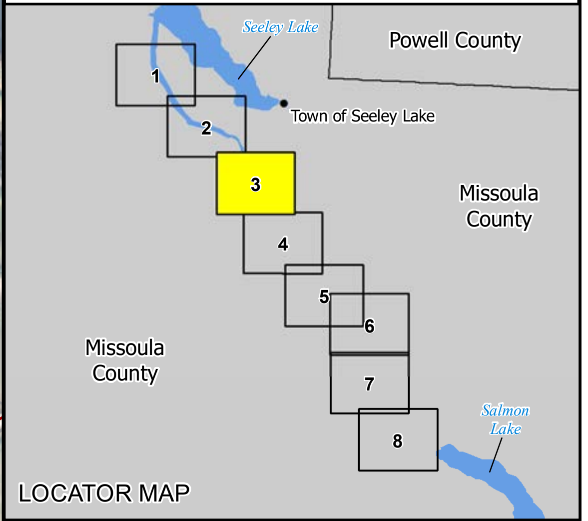

Clearwater River Map 3 of 8

CLEARWATER RIVER HYDRAULIC WORKMAP

February 20, 2020

LEGEND

- Study Profile Baseline
- Proposed 1-Percent-Annual Chance Event
- Proposed 0.2-Percent-Annual Chance Event
- Proposed Cross Section
- 10 FT Contour
- 5 FT Contour
- Interstate, US, State, or County Highway
- All Other Roads
- Political Area

Labels

5242.18 Water Surface Elevation

A Cross Section Letter 94889 River Station

0 100 200 300 400 Feet

1 inch = 400 feet

DATA FRAME PROPERTIES:

Coordinate System: NAD 1983 2011 StatePlane Montana FIPS 2500 Ft Int
Projection: Lambert Conformal Conic
Datum: NAD 1983 2011
Vertical Datum: NAVD 88
Units: Feet

Michael Baker INTERNATIONAL

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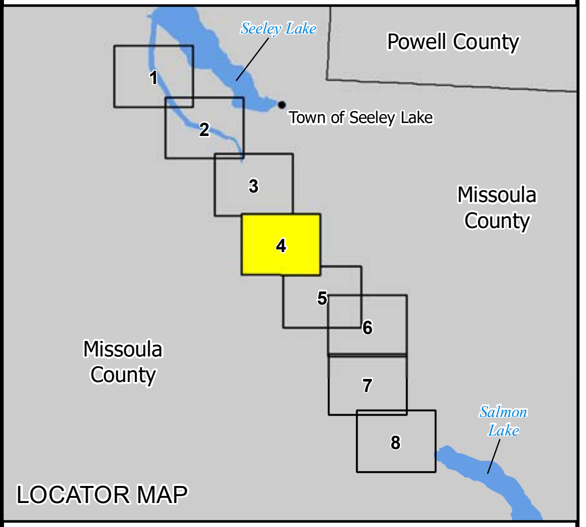
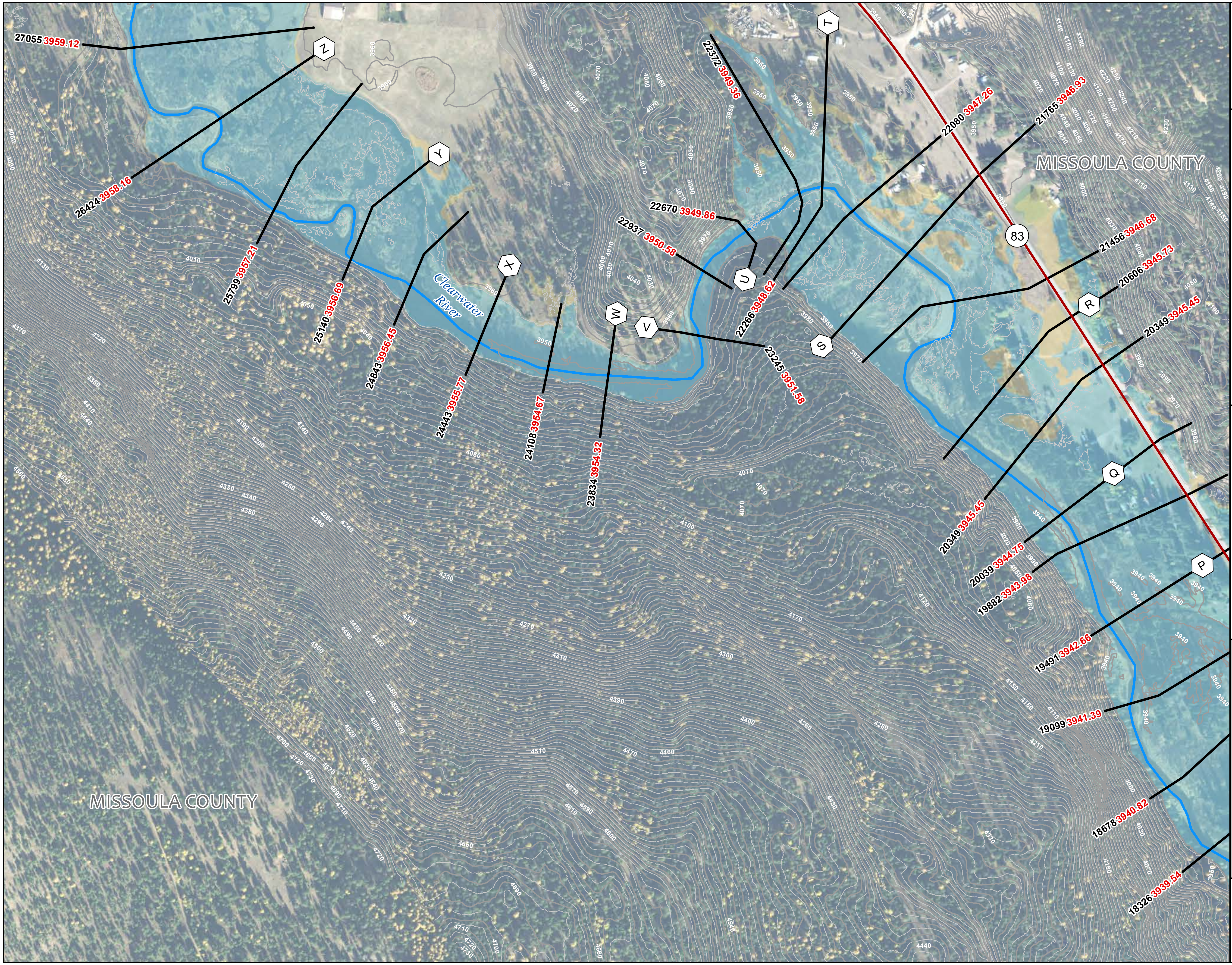
MONTANA DNRC



LOCATOR MAP

Clearwater River Map 4 of 8



CLEARWATER RIVER HYDRAULIC WORKMAP

February 20, 2020

LEGEND

- Study Profile Baseline
- Proposed 1-Percent-Annual Chance Event
- Proposed 0.2-Percent-Annual Chance Event
- Proposed Cross Section
- 10 FT Contour
- 5 FT Contour
- Interstate, US, State, or County Highway
- All Other Roads
- Political Area

Labels

5242.18 Water Surface Elevation

A Cross Section Letter

94889 River Station

0 100 200 300 400 Feet

1 inch = 400 feet

DATA FRAME PROPERTIES:

Coordinate System: NAD 1983 2011 StatePlane Montana FIPS 2500 Ft Int

Projection: Lambert Conformal Conic

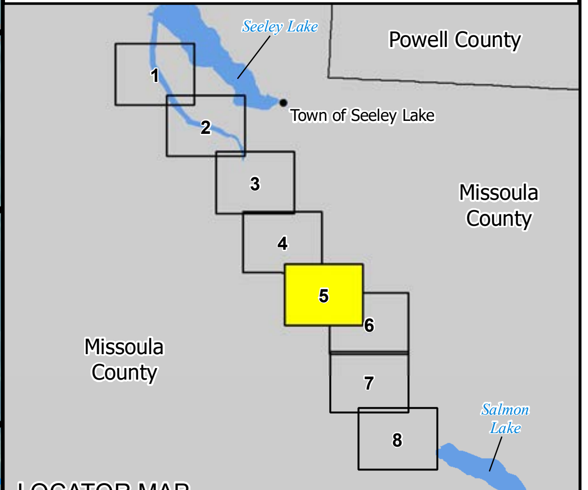
Datum: NAD 1983 2011

Vertical Datum: NAVD 88

Units: Feet

Michael Baker INTERNATIONAL

165 S. UNION BLVD.
SUITE 1000
LAKEWOOD, CO 80228
PHONE: 720-514-1100



LOCATOR MAP

Clearwater River Map 5 of 8

CLEARWATER RIVER HYDRAULIC WORKMAP

February 20, 2020

LEGEND

- Study Profile Baseline
- Proposed 1-Percent-Annual Chance Event
- Proposed 0.2-Percent-Annual Chance Event
- Proposed Cross Section
- 10 FT Contour
- 5 FT Contour
- Interstate, US, State, or County Highway
- All Other Roads
- Political Area

Labels

5242.18 Water Surface Elevation

A Cross Section Letter

94889 River Station

0 100 200 300 400 Feet

1 inch = 400 feet

DATA FRAME PROPERTIES:

Coordinate System: NAD 1983 2011 StatePlane Montana FIPS 2500 Ft Int

Projection: Lambert Conformal Conic

Datum: NAD 1983 2011

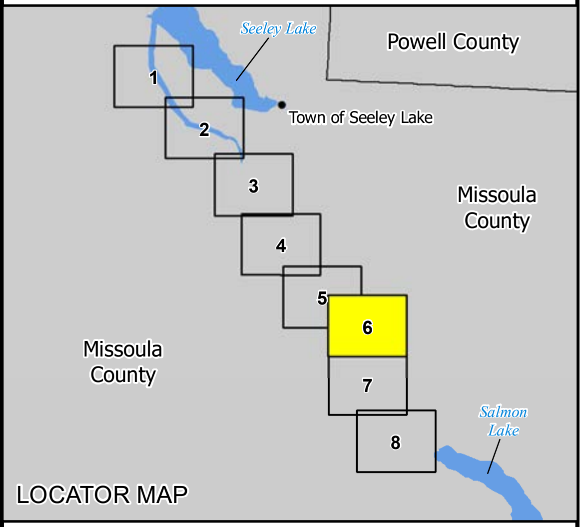
Vertical Datum: NAVD 88

Units: Feet

Michael Baker INTERNATIONAL

165 S. UNION BLVD.
SUITE 1000
LAKEWOOD, CO 80228
PHONE: 720-514-1100

MONTANA DNRC



Clearwater River Map 6 of 8

CLEARWATER RIVER HYDRAULIC WORKMAP

February 20, 2020

LEGEND

- Study Profile Baseline
- Proposed 1-Percent-Annual Chance Event
- Proposed 0.2-Percent-Annual Chance Event
- Proposed Cross Section
- 10 FT Contour
- 5 FT Contour
- Interstate, US, State, or County Highway
- All Other Roads
- Political Area

Labels

5242.18 Water Surface Elevation

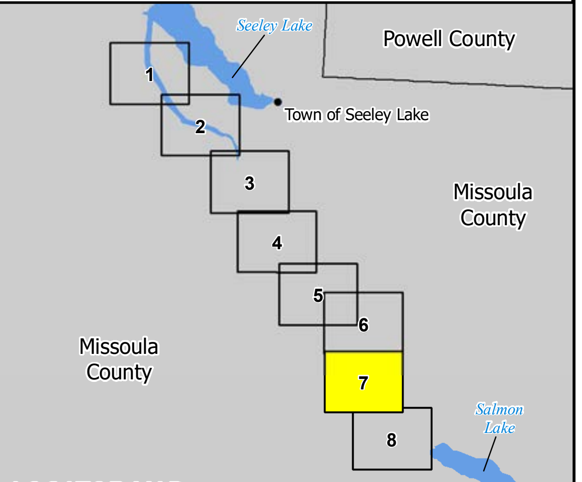
A Cross Section Letter 94889 River Station

0 100 200 300 400 Feet

1 inch = 400 feet

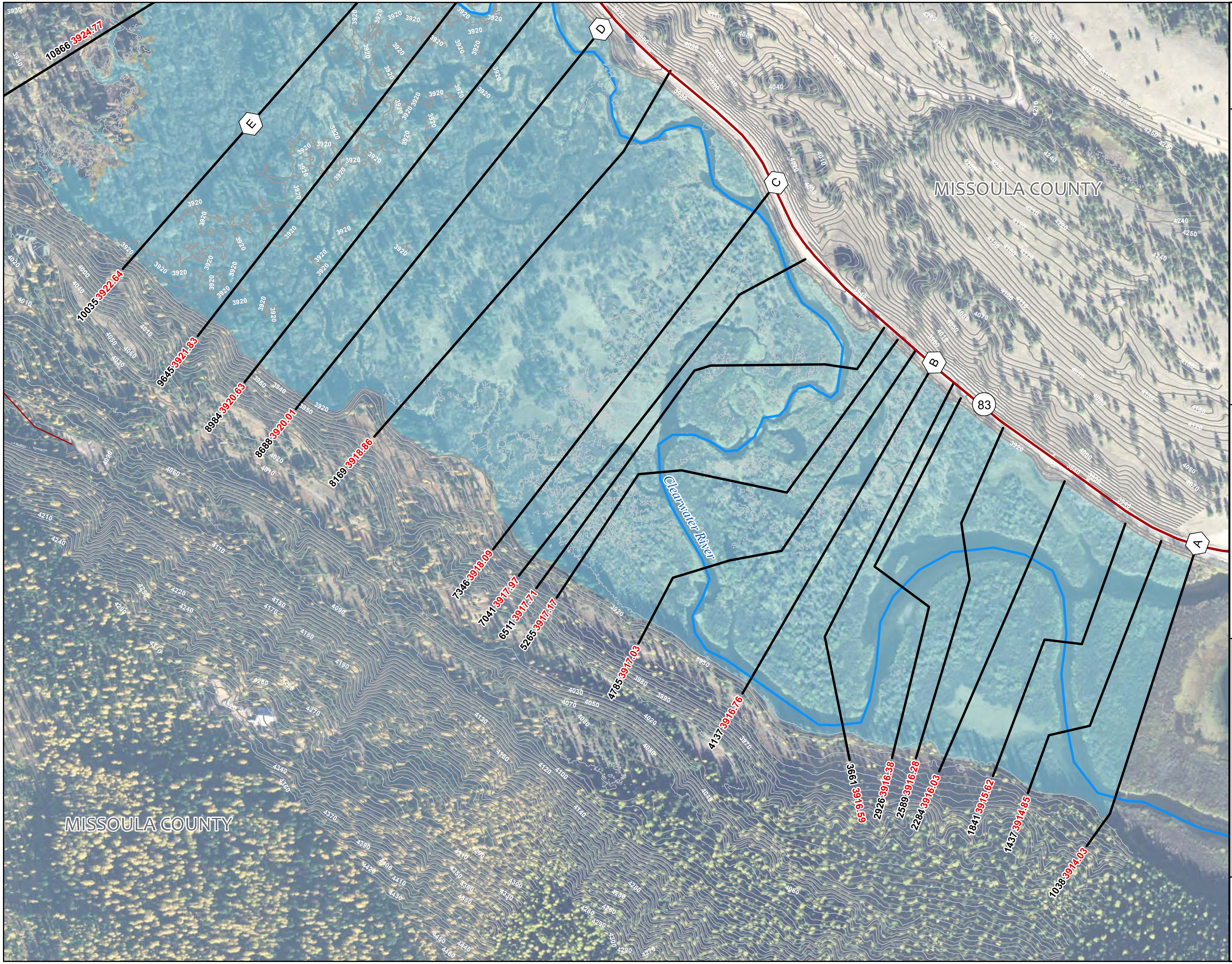
DATA FRAME PROPERTIES:
Coordinate System: NAD 1983 2011 StatePlane Montana FIPS 2500 Ft Int
Projection: Lambert Conformal Conic
Datum: NAD 1983 2011
Vertical Datum: NAVD 88
Units: Feet

Michael Baker INTERNATIONAL
165 S. UNION BLVD.
SUITE 1000
LAKEWOOD, CO 80228
PHONE: 720-514-1100



LOCATOR MAP

Clearwater River Map 7 of 8



CLEARWATER RIVER HYDRAULIC WORKMAP

February 20, 2020

LEGEND

- Study Profile Baseline
- Proposed 1-Percent-Annual Chance Event
- Proposed 0.2-Percent-Annual Chance Event
- Proposed Cross Section
- 10 FT Contour
- 5 FT Contour
- Interstate, US, State, or County Highway
- All Other Roads
- Political Area

Labels

5242.18 Water Surface Elevation

A Cross Section Letter — **94889** River Station

0 100 200 300 400 Feet

1 inch = 400 feet

DATA FRAME PROPERTIES:

Coordinate System: NAD 1983 2011 StatePlane Montana FIPS 2500 Ft Int

Projection: Lambert Conformal Conic

Datum: NAD 1983 2011

Vertical Datum: NAVD 88

Units: Feet

Michael Baker INTERNATIONAL

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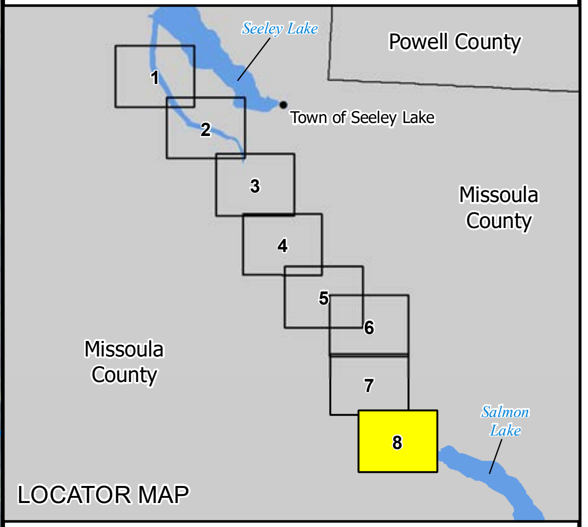
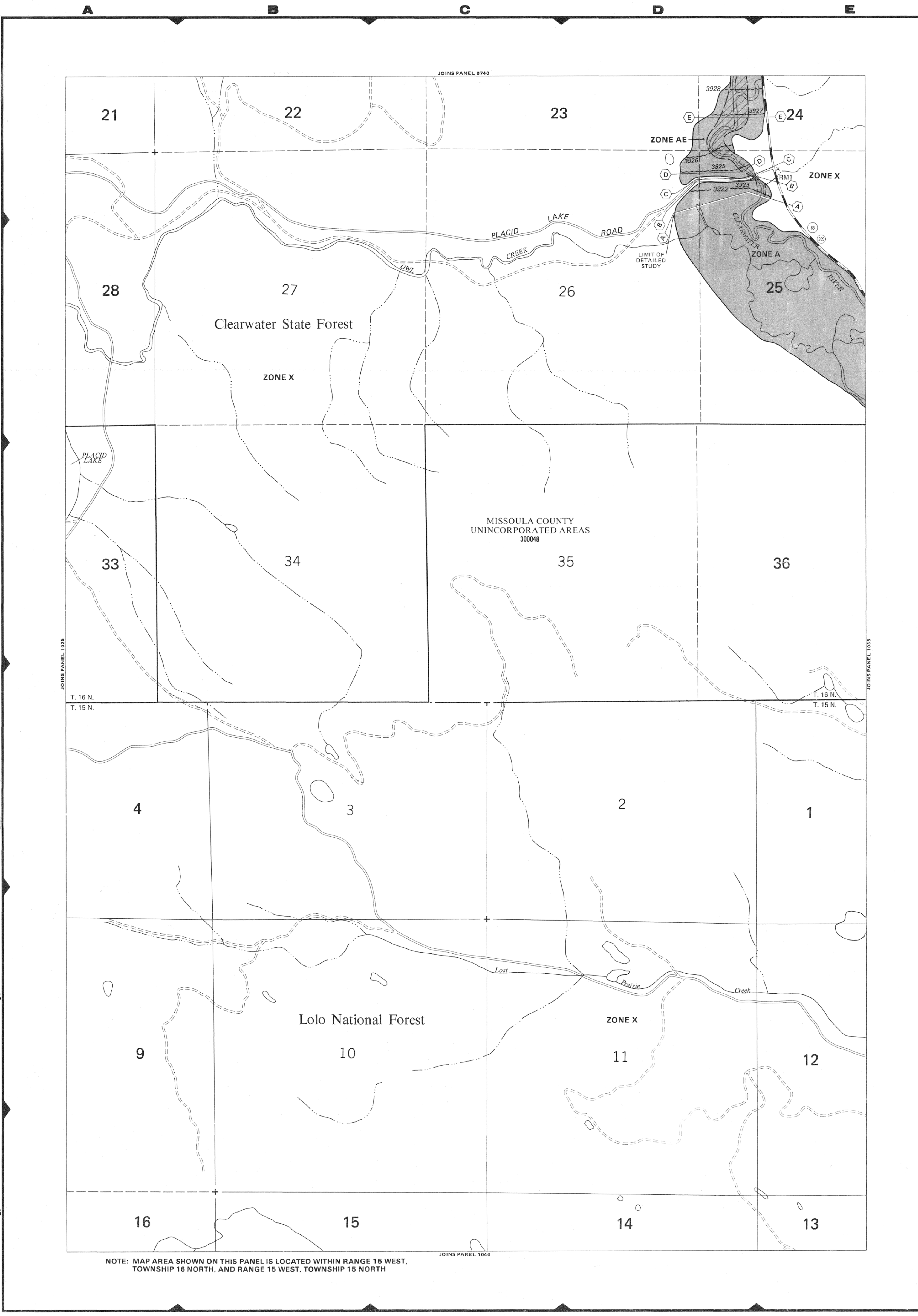


Clearwater River Map 8 of 8

Appendix C
Effective FIRM Maps

Clearwater River - Physical Map Revision
Enhanced Hydraulic Analysis Report

Missoula County



NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN RANGE 15 WEST, TOWNSHIP 16 NORTH, AND RANGE 15 WEST, TOWNSHIP 15 NORTH

LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

- **ZONE A** No base flood elevations determined.
- **ZONE AE** Base flood elevations determined.
- **ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.
- **ZONE A0** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- **ZONE A99** To be protected from 100-year flood by Federal flood protection system under construction; no base elevations determined.
- **ZONE V** Coastal flood with velocity hazard (wave action); no base flood elevations determined.
- **ZONE VE** Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

- **ZONE X** Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

- **ZONE X** Areas determined to be outside 500-year flood plain.
- **ZONE D** Areas in which flood hazards are undetermined.

Flood Boundary

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

513 Base Flood Elevation Line; Elevation in Feet*

D D Cross Section Line

(EL 987) Base Flood Elevation in Feet Where Uniform Within Zone*

RM7 X Elevation Reference Mark

*Referenced to the National Geodetic Vertical Datum of 1929

NOTES

This map is for use in administering the National Flood Insurance Program; it does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size, or all planimetric features outside Special Flood Hazard Areas.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Emergency Management Agency.

Floodway widths in some areas may be too narrow to show to scale. Floodway widths are provided in the Flood Insurance Study Report.

Coastal base flood elevations apply only landward of the shoreline.

Elevation reference marks are described in the Flood Insurance Study Report.

Corporate limits shown are current as of the date of this map. The user should contact appropriate community officials to determine if corporate limits have changed subsequent to the issuance of the map.

For community map revision history prior to countywide mapping, see Section 6.0 of the Flood Insurance Study Report.

For adjoining map panels see separately printed Map Index.

MAP REPOSITORY
Refer to Repository Listing on Index Map

EFFECTIVE DATE OF
COUNTYWIDE FLOOD INSURANCE RATE MAP:
AUGUST 16, 1988

EFFECTIVE DATE (S) OF REVISION (S) TO THIS PANEL:

Refer to Flood Insurance Rate Map Effective date shown below to determine when actuarial rates apply to structures in zones where elevations or depths have been established.

To determine if flood insurance is available, contact an insurance agent or call the National Flood Insurance Program at (800) 638-6620.

N

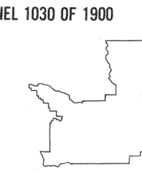
APPROXIMATE SCALE IN FEET
1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

MISSOULA COUNTY, MONTANA AND INCORPORATED AREAS

PANEL 1030 OF 1900



PANEL LOCATION

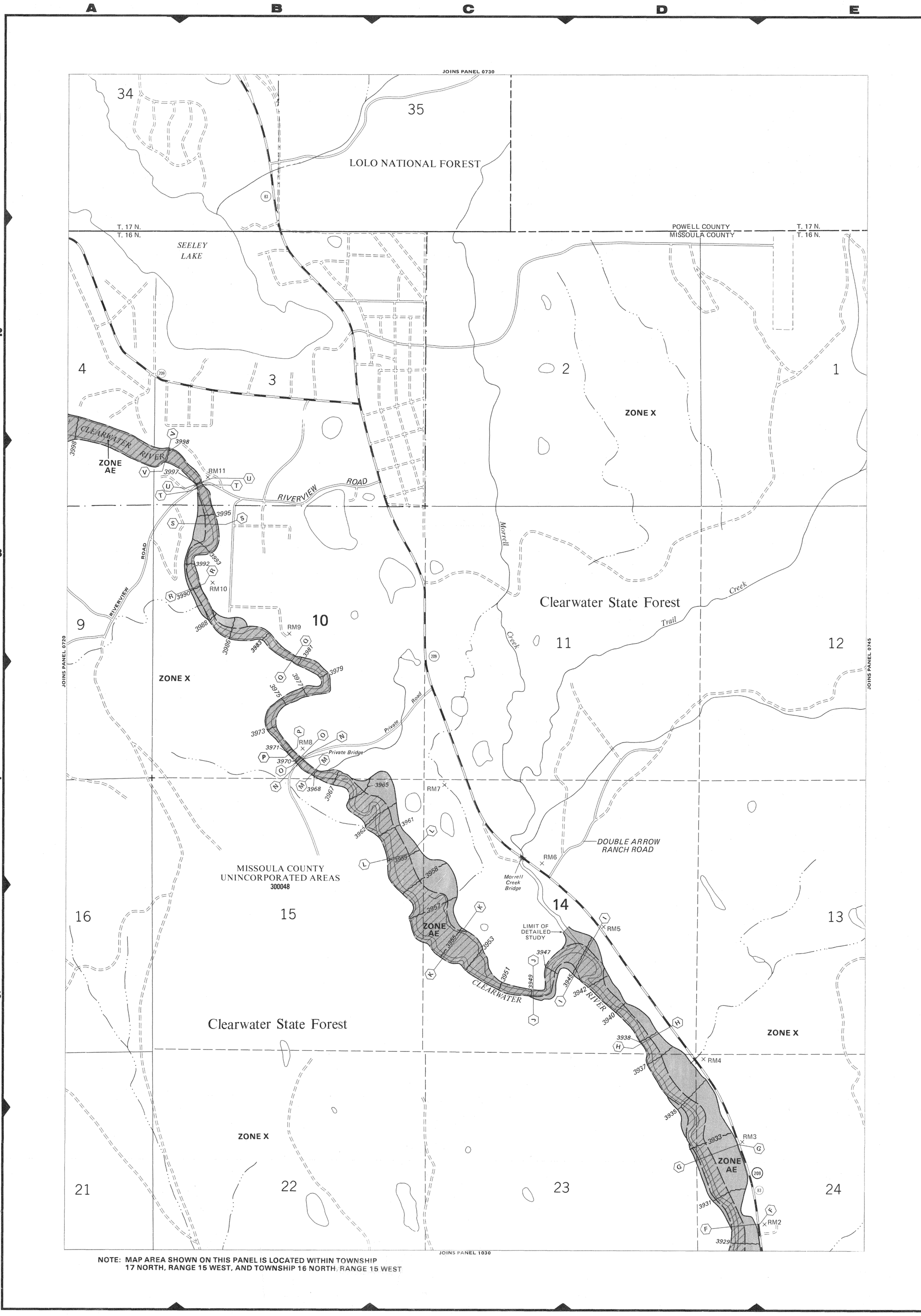
CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
UNINCORPORATED AREAS	300048	1030	D

MAP NUMBER
30063C1030 D

EFFECTIVE DATE:
AUGUST 16, 1988

Federal Emergency Management Agency



NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 17 NORTH, RANGE 15 WEST, AND TOWNSHIP 16 NORTH, RANGE 15 WEST

LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

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- **ZONE AE** Base flood elevations determined.
- **ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.
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- **ZONE V** Coastal flood with velocity hazard (wave action); no base flood elevations determined.
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FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

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OTHER AREAS

- **ZONE X** Areas determined to be outside 500-year flood plain.
- **ZONE D** Areas in which flood hazards are undetermined.

Flood Boundary

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

~~~~513~~~~ Base Flood Elevation Line; Elevation in Feet*

(D)——(D) Cross Section Line

(EL 987) Base Flood Elevation in Feet Where Uniform Within Zone*

RM7 X Elevation Reference Mark

*Referenced to the National Geodetic Vertical Datum of 1929

NOTES

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MAP REPOSITORY
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EFFECTIVE DATE OF
COUNTYWIDE FLOOD INSURANCE RATE MAP:
AUGUST 16, 1988

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To determine if flood insurance is available, contact an insurance agent or call the National Flood Insurance Program at (800) 638-6620.

APPROXIMATE SCALE IN FEET
1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

MISSOULA COUNTY, MONTANA AND INCORPORATED AREAS

PANEL 740 OF 1900

PANEL LOCATION

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
UNINCORPORATED AREAS	300048	0740	D

MAP NUMBER
30063C0740 D

EFFECTIVE DATE:
AUGUST 16, 1988

Federal Emergency Management Agency
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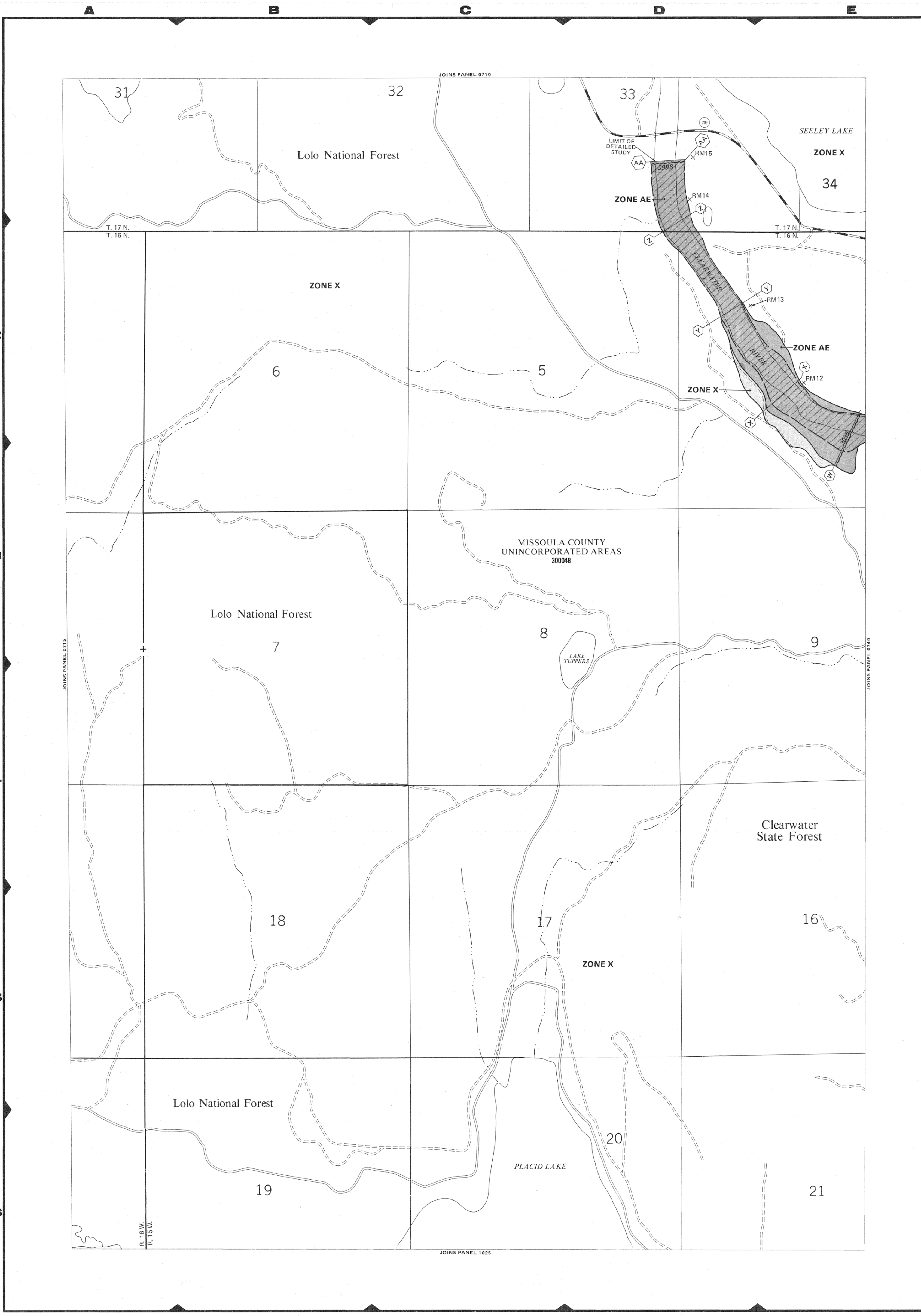

LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

ZONE A	No base flood elevations determined.
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ZONE A99	To be protected from 100-year flood by Federal flood protection system under construction; no base elevations determined.
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ZONE VE	Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

ZONE X	Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

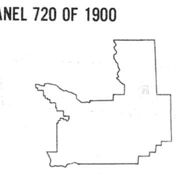
ZONE X	Areas determined to be outside 500-year flood plain.
ZONE D	Areas in which flood hazards are undetermined.

Flood Boundary

Floodway Boundary

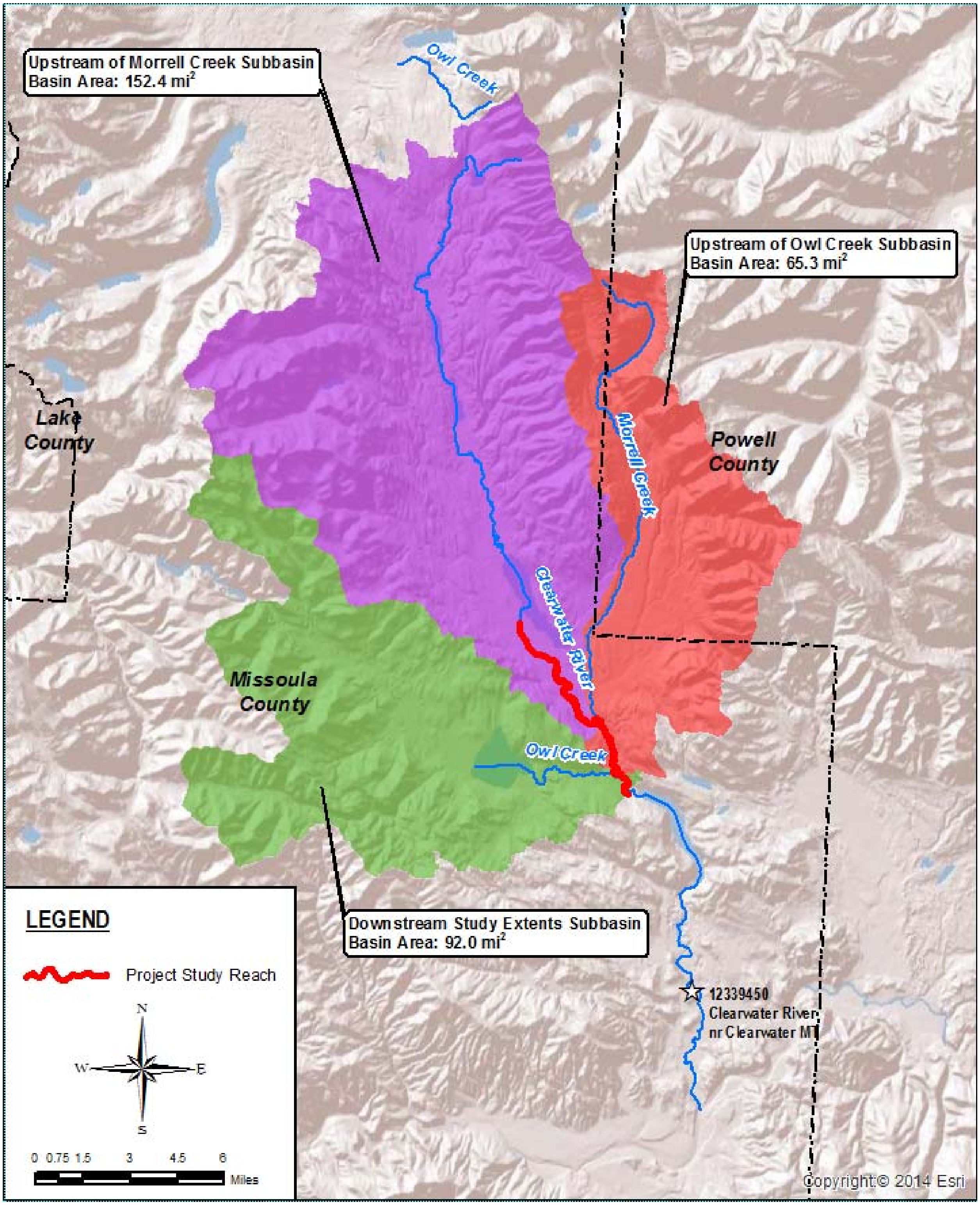
Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

~~~513~~~ Base Flood Elevation Line; Elevation in Feet*

(D)———(D) Cross Section Line

(EL 987) Base Flood Elevation in Feet Where Uniform Within Zone*

RM7 X Elevation Reference Mark

*Referenced to the National Geodetic Vertical Datum of 1929

NOTES

This map is for use in administering the National Flood Insurance Program; it does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size, or all planimetric features outside Special Flood Hazard Areas.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Emergency Management Agency.

Floodway widths in some areas may be too narrow to show to scale. Floodway widths are provided in the Flood Insurance Study Report.

Coastal base flood elevations apply only landward of the shoreline.

Elevation reference marks are described in the Flood Insurance Study Report.

Corporate limits shown are current as of the date of this map. The user should contact appropriate community officials to determine if corporate limits have changed subsequent to the issuance of the map.

For community map revision history prior to countywide mapping, see Section 6.0 of the Flood Insurance Study Report.

For adjoining map panels see separately printed Map Index.

MAP REPOSITORY
Refer to Repository Listing on Index Map

EFFECTIVE DATE OF
COUNTYWIDE FLOOD INSURANCE RATE MAP:
AUGUST 16, 1988

EFFECTIVE DATE (S) OF REVISION (S) TO THIS PANEL:

Refer to Flood Insurance Rate Map Effective date shown below to determine when actuarial rates apply to structures in zones where elevations or depths have been established.

To determine if flood insurance is available, contact an insurance agent or call the National Flood Insurance Program at (800) 638-6620.

N

APPROXIMATE SCALE IN FEET
1000 0 1000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

MISSOULA COUNTY,
MONTANA AND
INCORPORATED AREAS

PANEL 720 OF 1900



PANEL LOCATION

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
UNINCORPORATED AREAS	300048	0720	D

MAP NUMBER
30063C0720 D

EFFECTIVE DATE:
AUGUST 16, 1988

Federal Emergency Management Agency
~~~

Appendix D
Watershed Work Maps

Figure 3: Drainage Basin Area



Appendix E
Study Area Photographs

Flooding Source: Clearwater River

Surveyor's Station: Riverview Drive

Hec-RAS Station: 40757

9-18-14 041.jpg

9-18-14 042.jpg

9-18-14 043.jpg

9-18-14 044.jpg

9-18-14 045.jpg

19-18-14 046.jpg

19-18-14 047.jpg

19-18-14 048.jpg

19-18-14 049.jpg

19-18-14 050.jpg

19-18-14 051.jpg

19-18-14 052.jpg

Flooding Source: Clearwater River

Surveyor's Station: WWct bridge

Hec-RAS Station: 34165

WWct bridge down st.JPG

WWct bridge up.JPG

WWct bridge upstream.JPG

WWct down st.JPG

Flooding Source: Clearwater River

Surveyor Station: Wagon Wheel Way

Hec-RAS Station: 32091

19-18-14 028.jpg

19-18-14 029.jpg

19-18-14 030.jpg

19-18-14 031.jpg

19-18-14 032.jpg

19-18-14 033.jpg

19-18-14 034.jpg

19-18-14 037.jpg

19-18-14 035.jpg

19-18-14 038.jpg

19-18-14 036.jpg

19-18-14 039.jpg

19-18-14 040.jpg

WWway down st.JPG

WWway bridge down st.JPG

WWway up st.JPG

WWway bridge up st.JPG

Flooding Source: Clearwater River

Surveyor's Station: Placid Creek Road

Hec-RAS Station: 12144

9-18-14 011.jpg

9-18-14 012.jpg

9-18-14 013.jpg

9-18-14 014.jpg

9-18-14 015.jpg

9-18-14 016.jpg


9-18-14 017.jpg


9-18-14 018.jpg


9-18-14 019.jpg


9-18-14 020.jpg


9-18-14 021.jpg


9-18-14 022.jpg


9-18-14 023.jpg


9-18-14 024.jpg


9-18-14 025.jpg

Appendix F
Modeled Cross Section Geometries

Clearwater River - Physical Map Revision
Enhanced Hydraulic Analysis Report

Missoula County

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020

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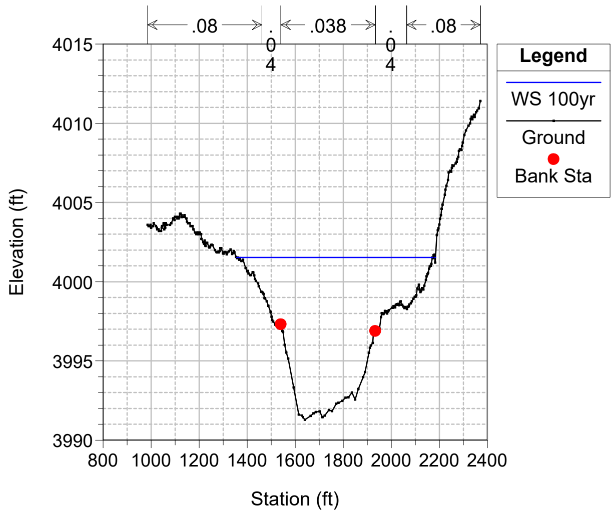

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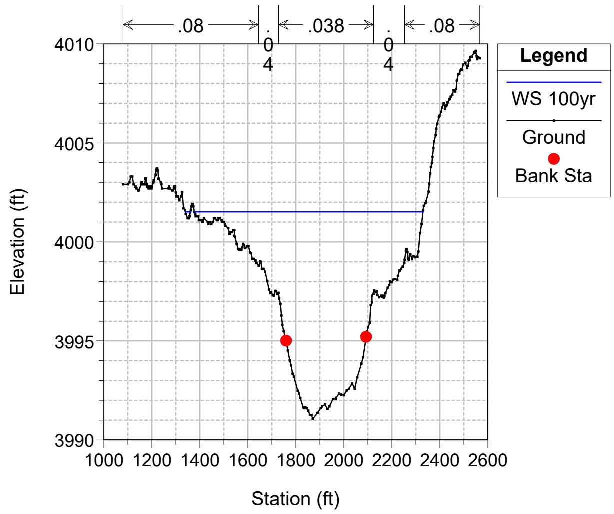

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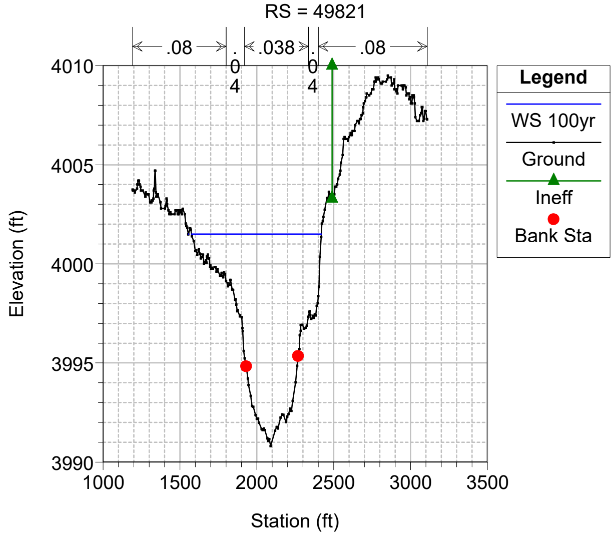

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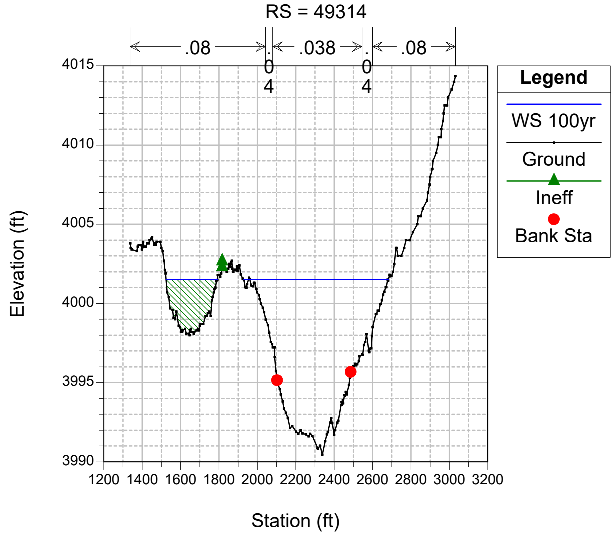

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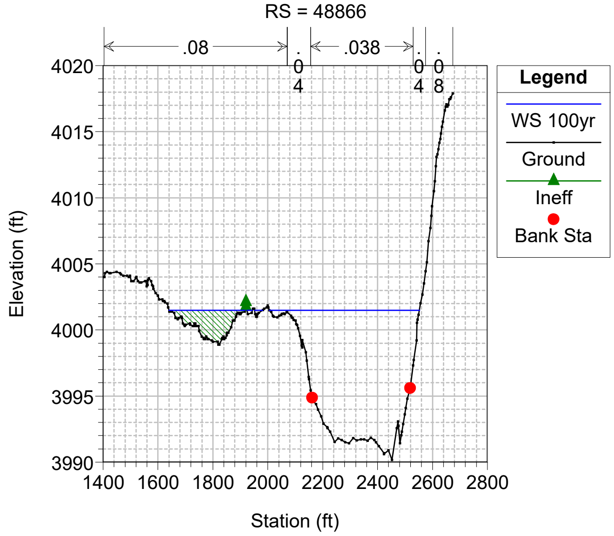

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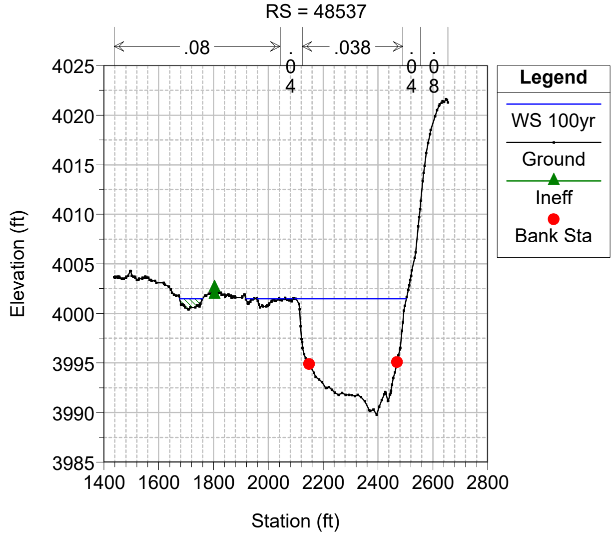

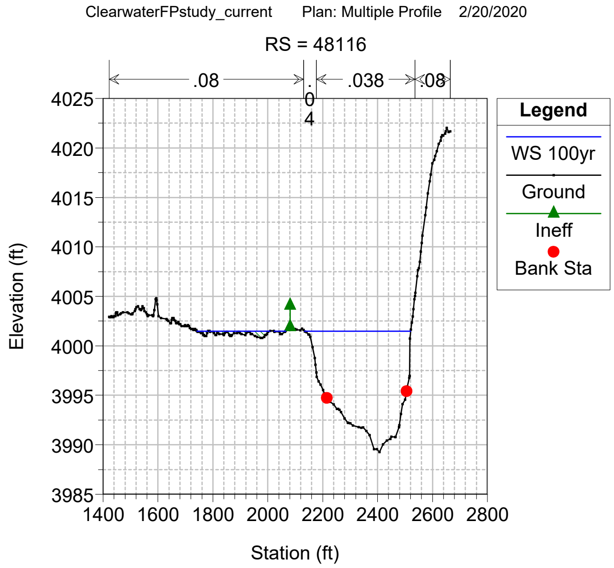
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Legend
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Ground
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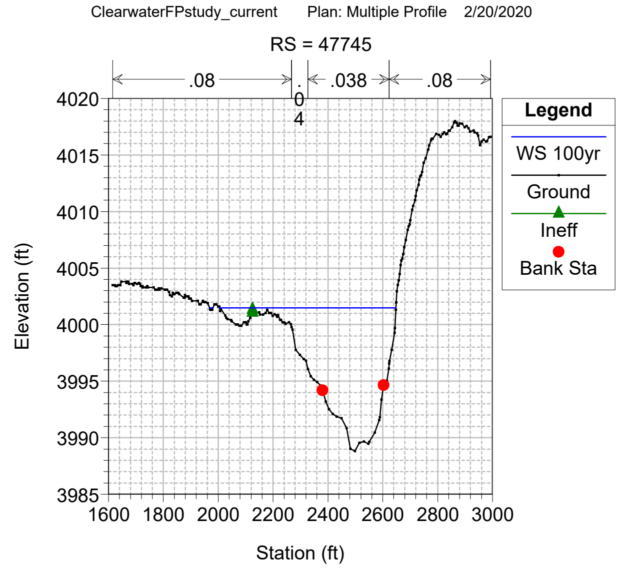
Bank Sta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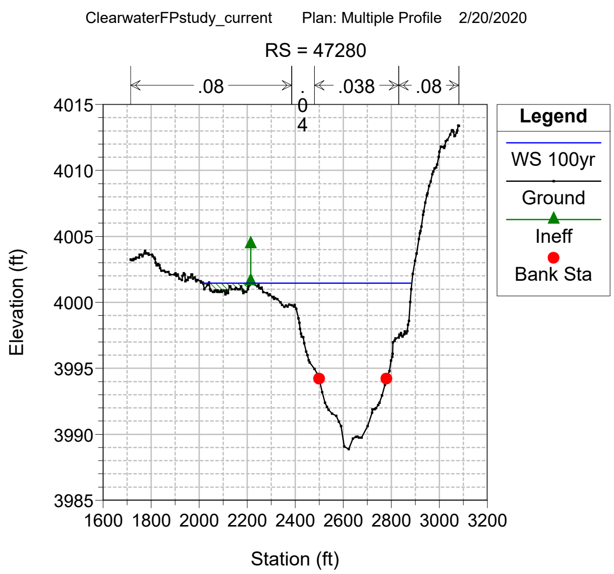
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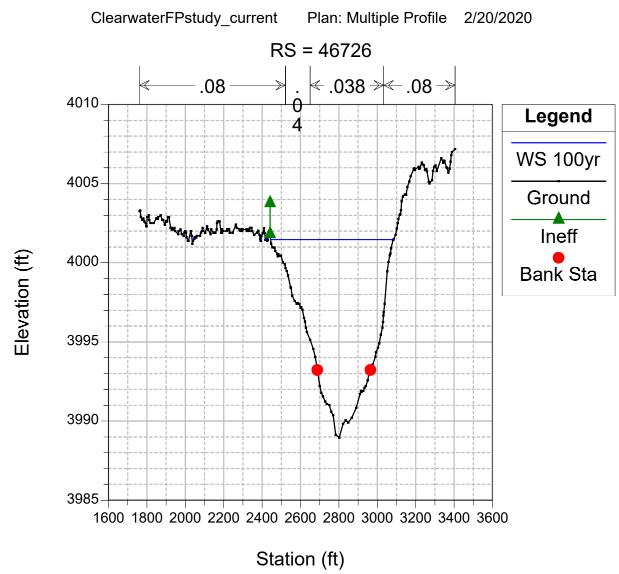
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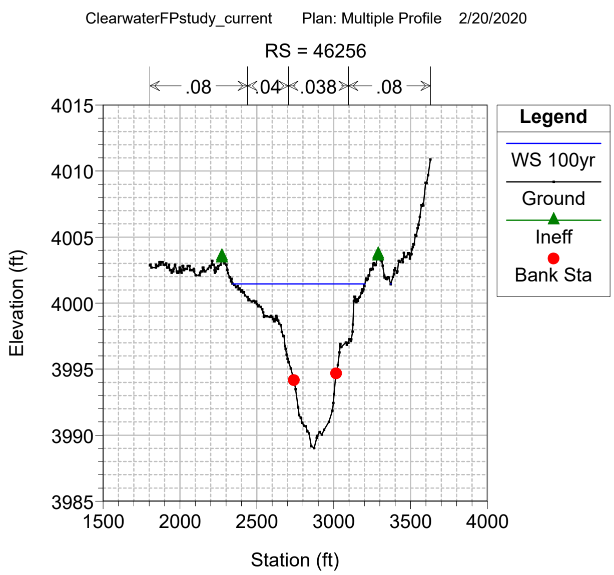
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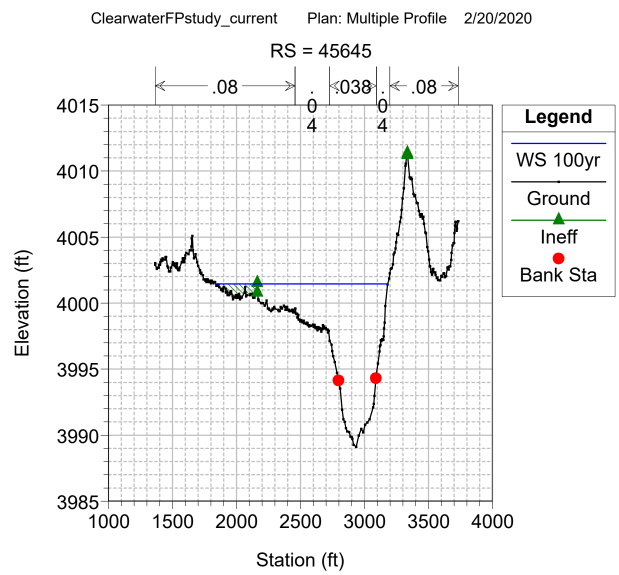
Bank Sta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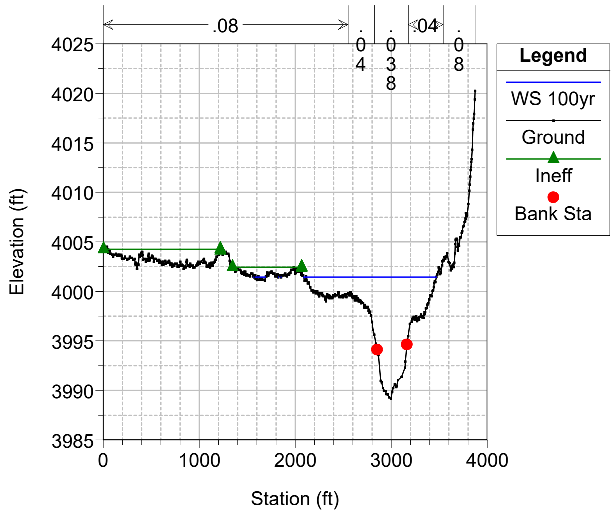

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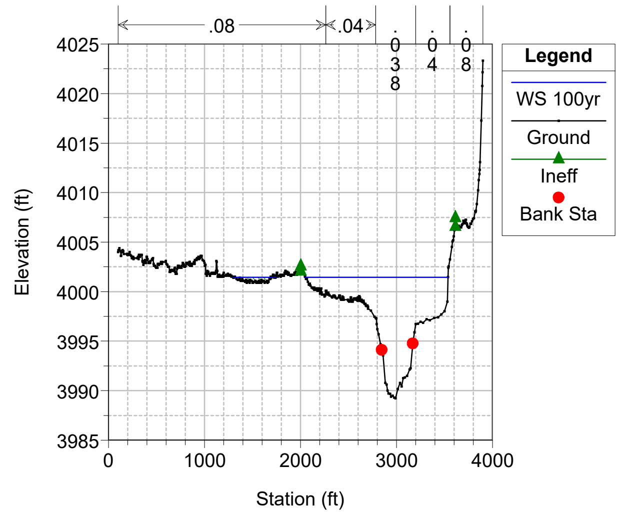

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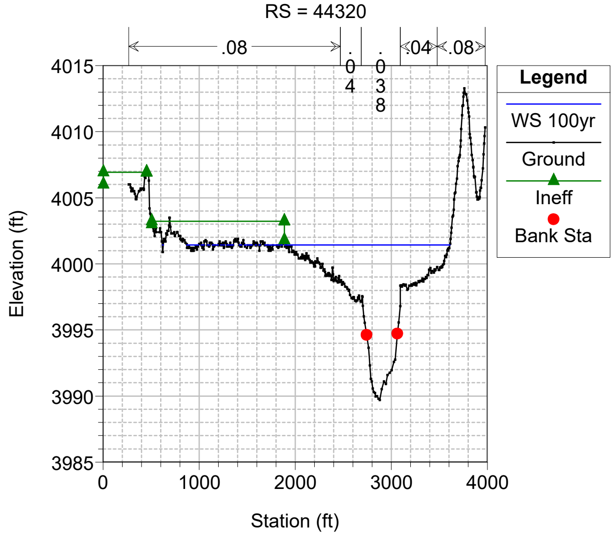

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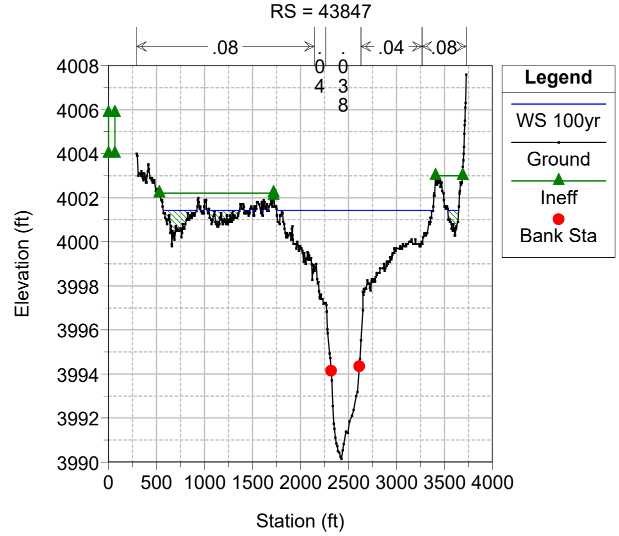

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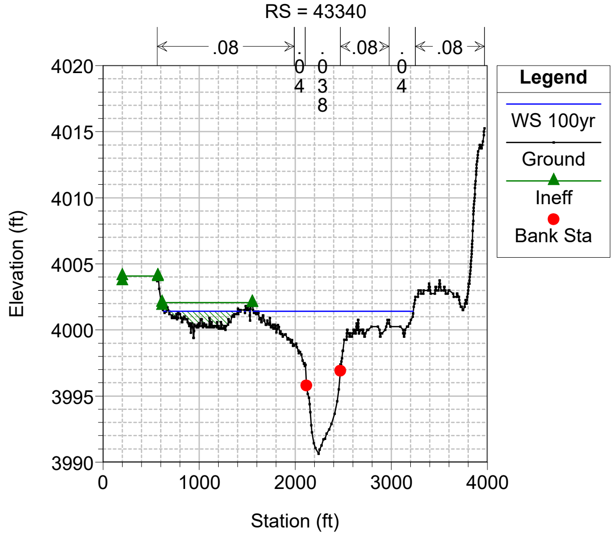

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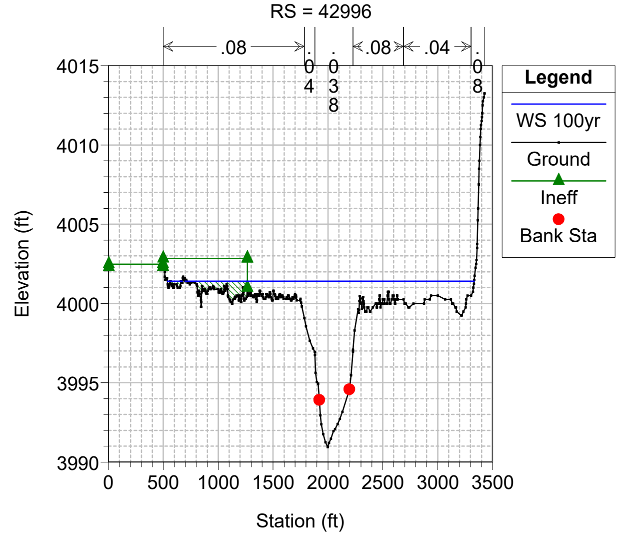

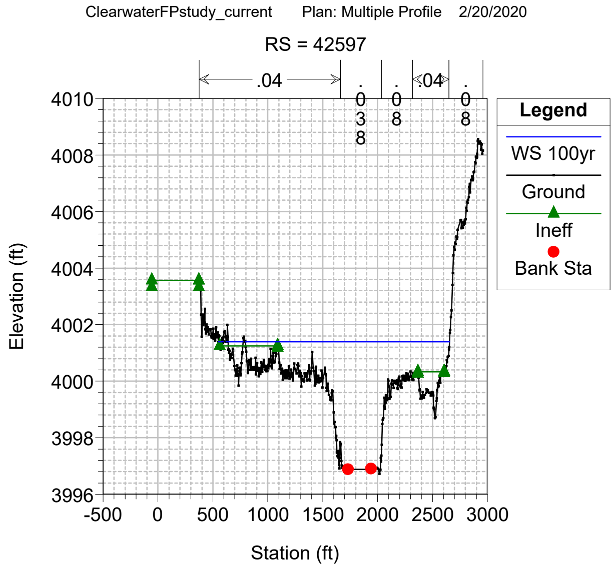
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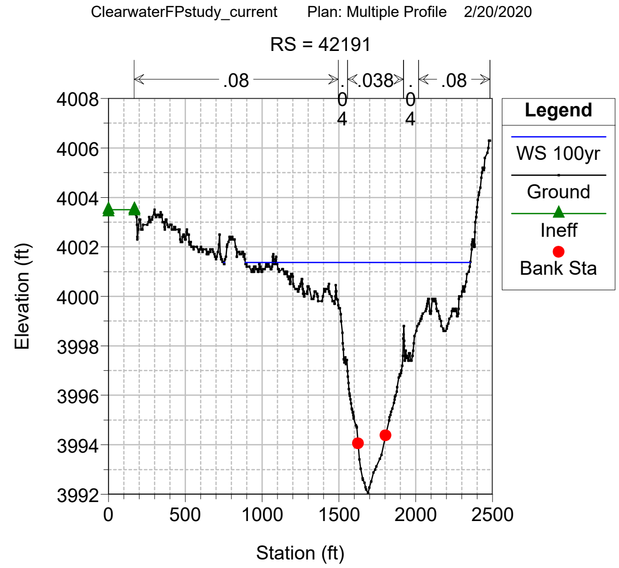
Bank Sta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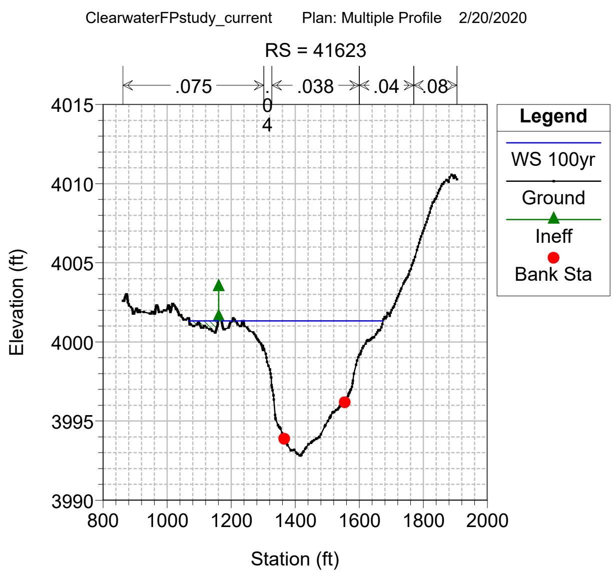
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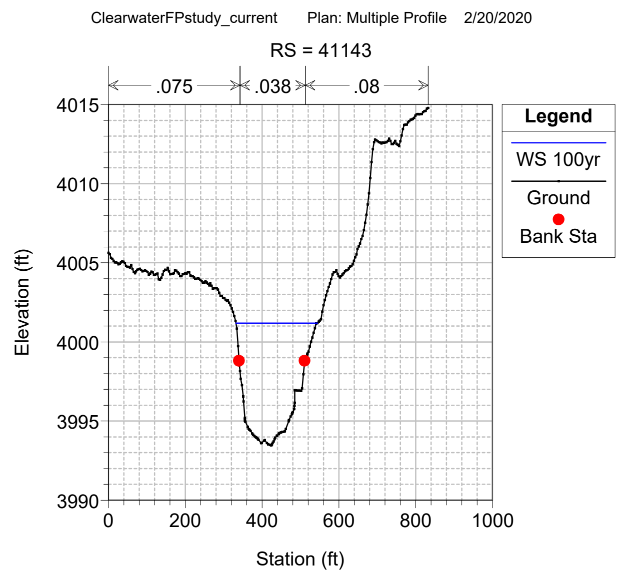
Bank Sta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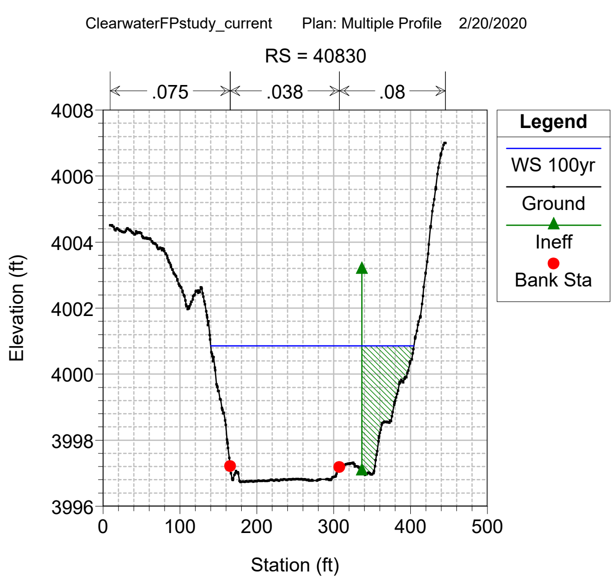
Bank Sta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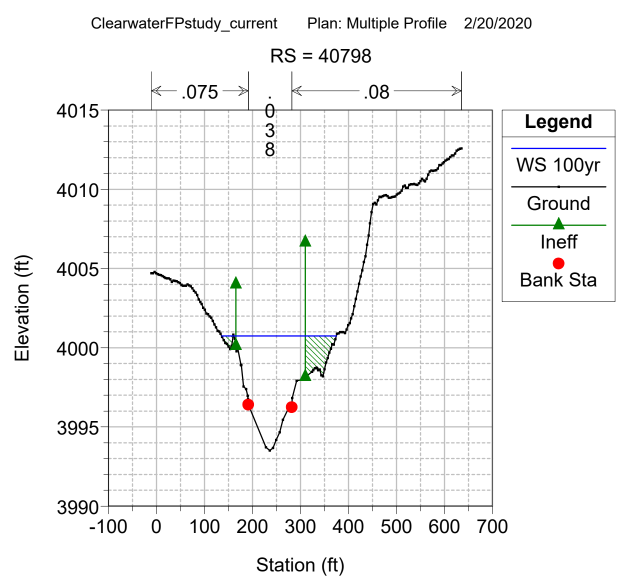
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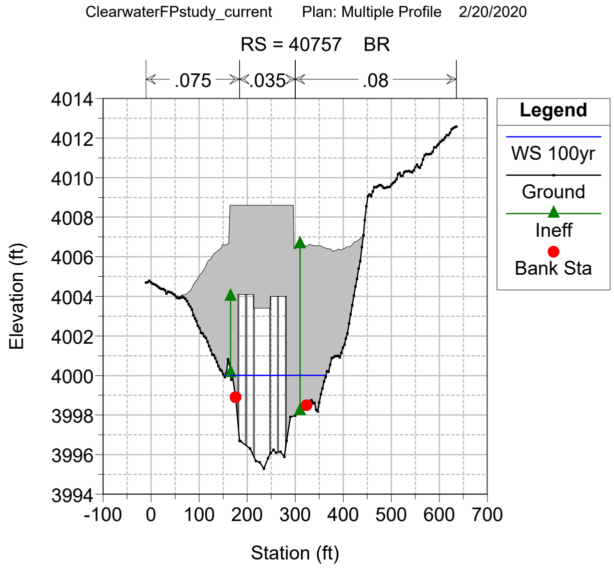
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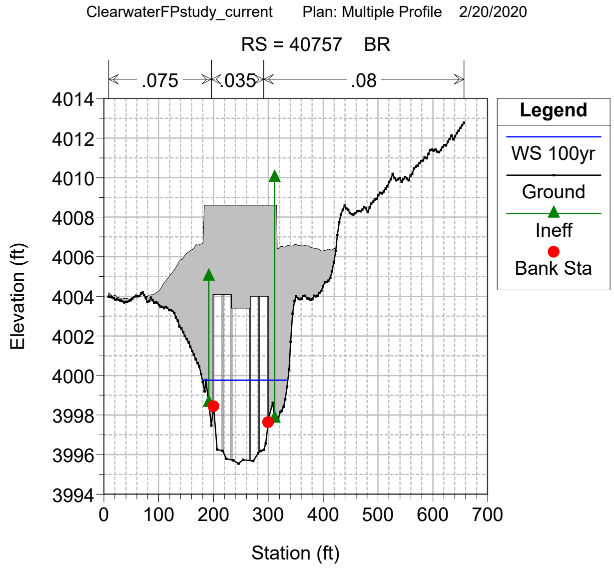
Bank Sta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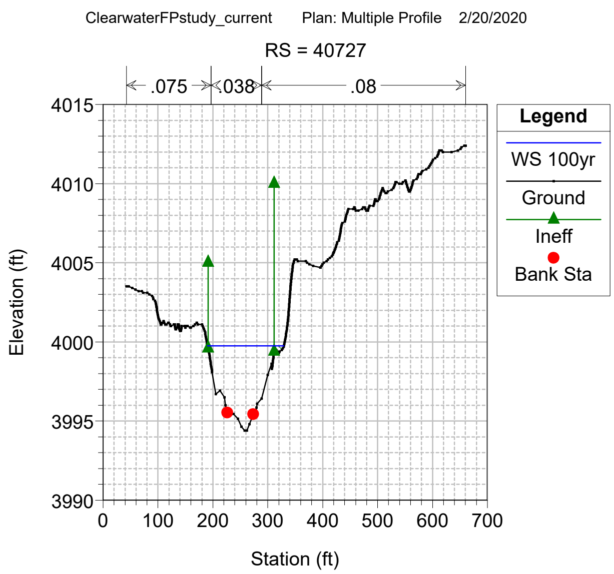
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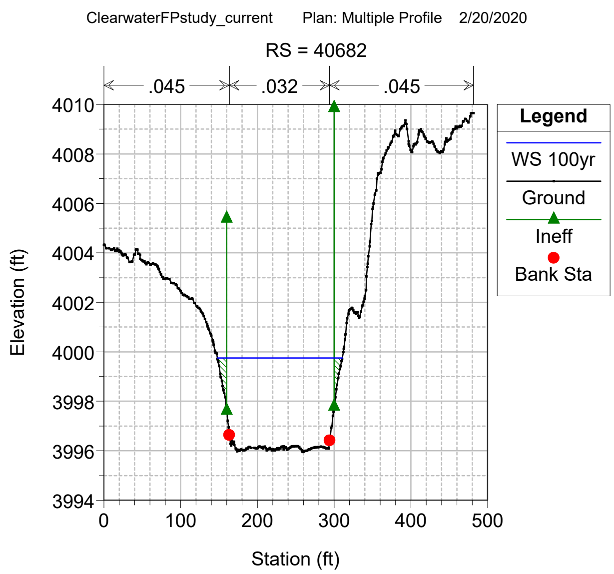
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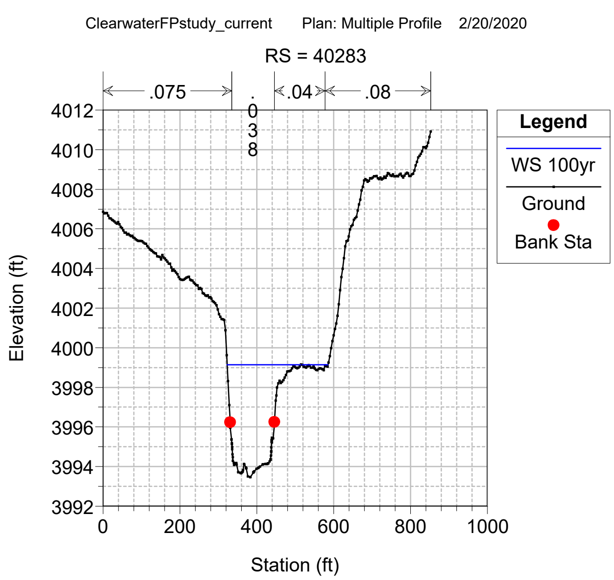
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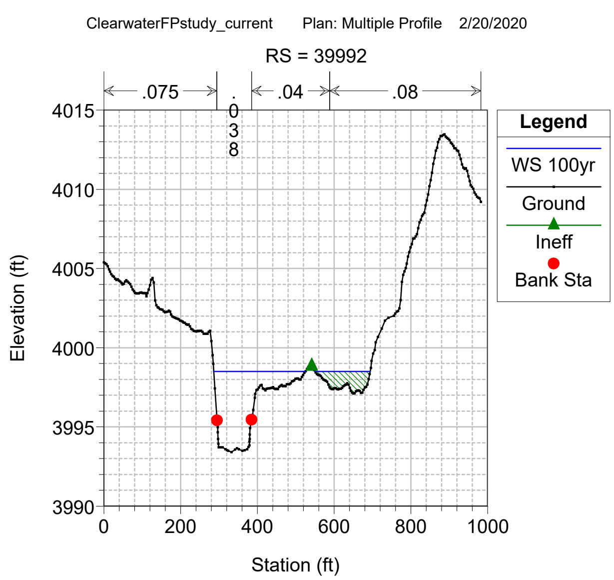
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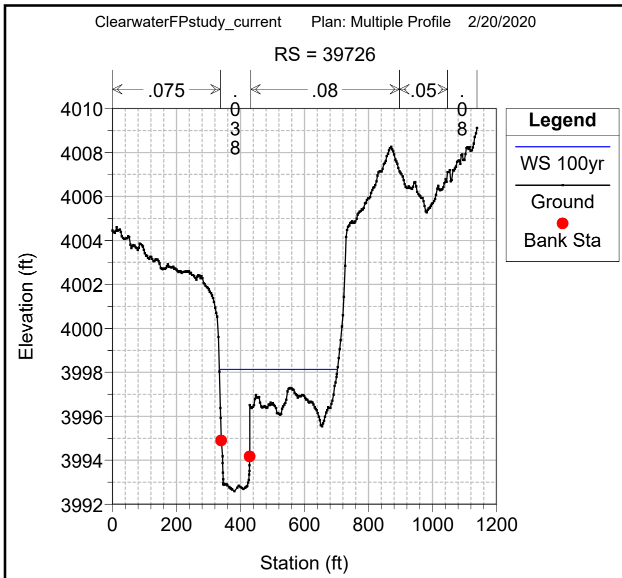
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Ground
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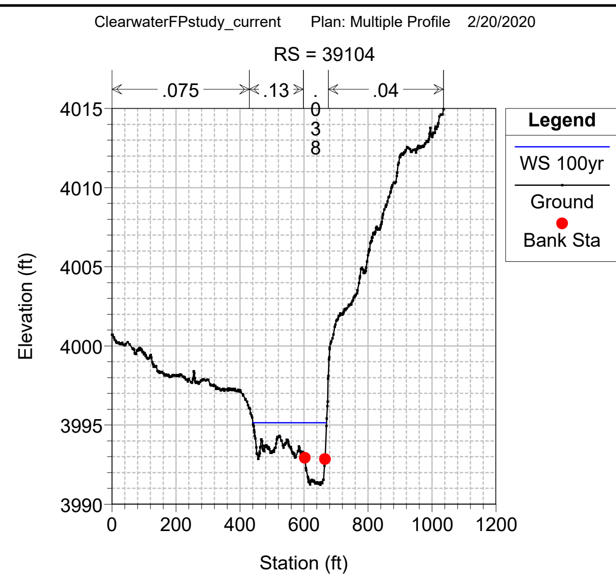
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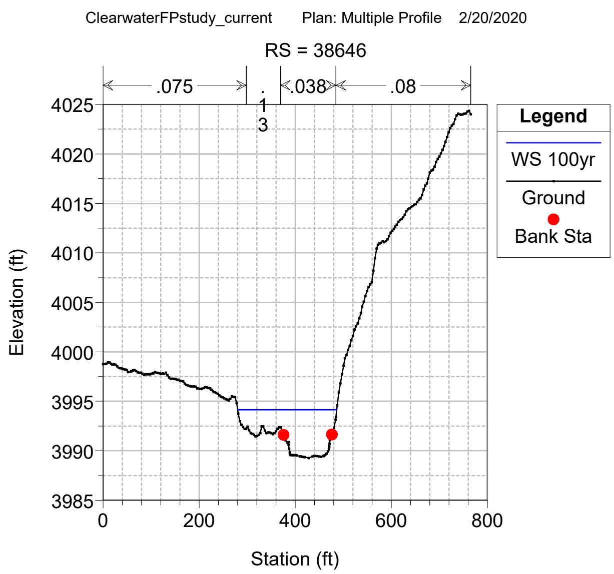
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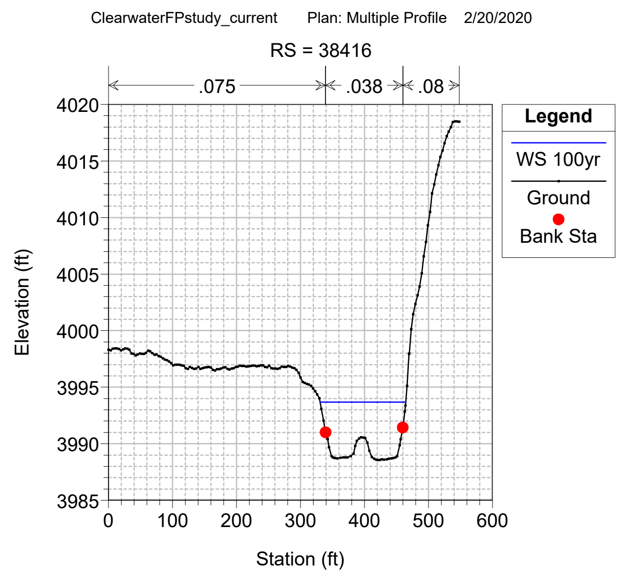
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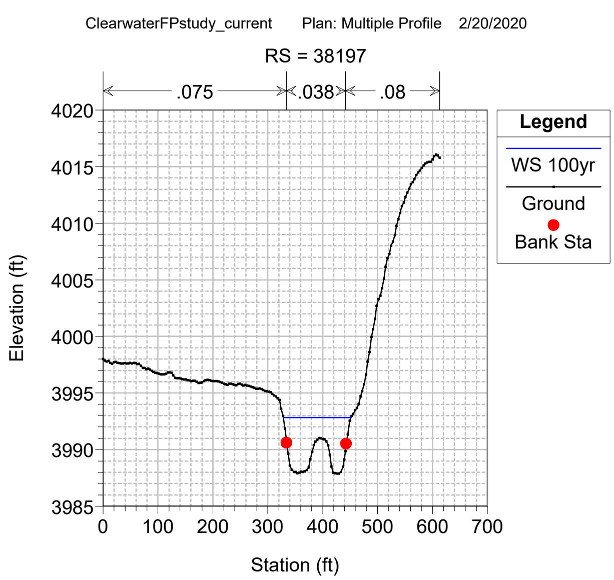
Ground
Bank Sta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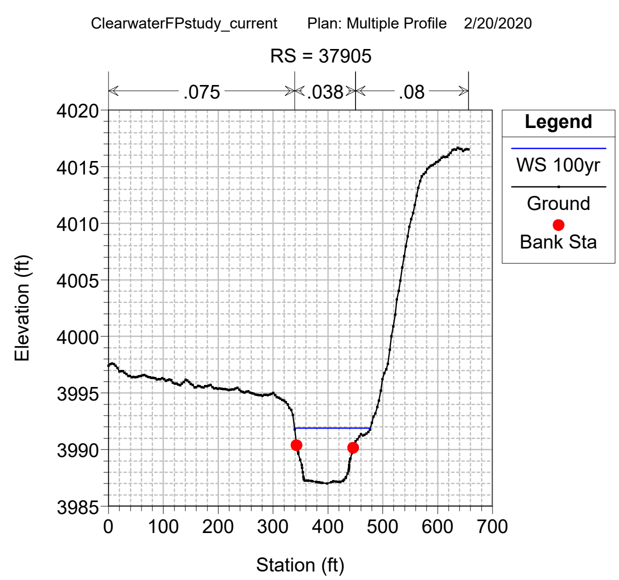
Ground
Bank Sta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Station (ft)
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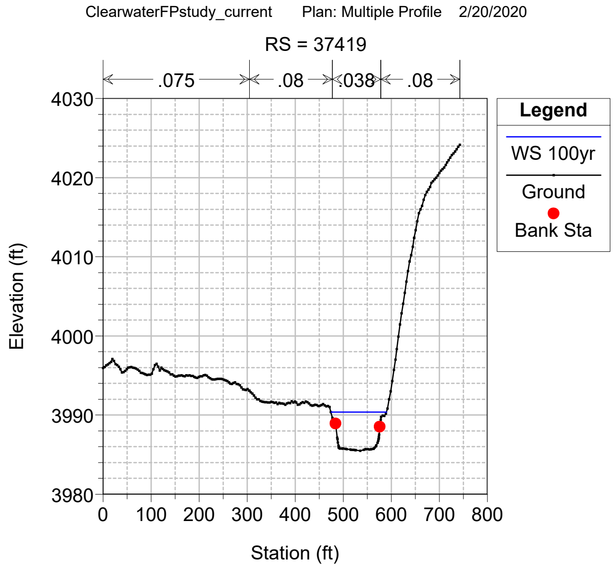
Legend
WS 100yr
Ground
Bank Sta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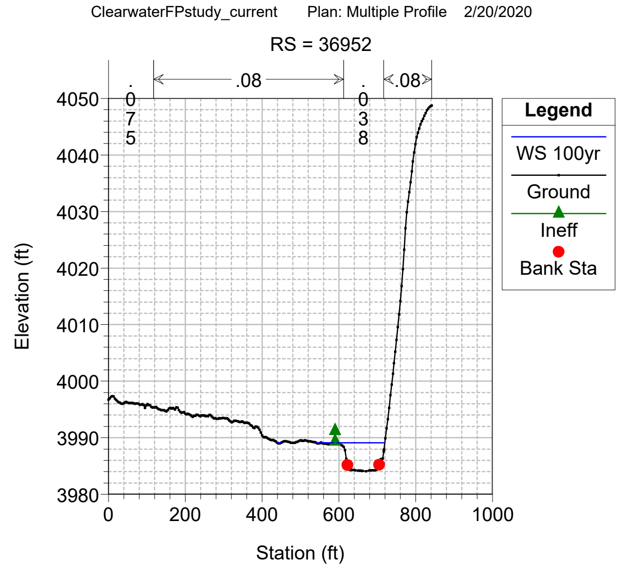
Station (ft)
Legend
WS 100yr
Ground
Bank Sta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800
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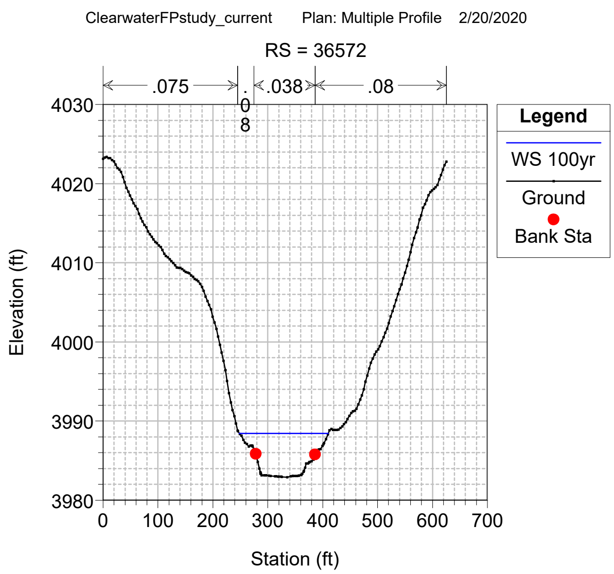
Station (ft)
Legend
WS 100yr
Ground
Ineff
Bank Sta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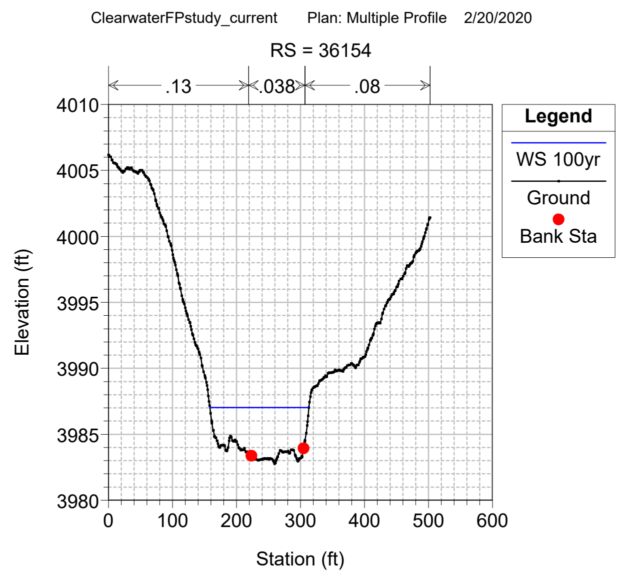
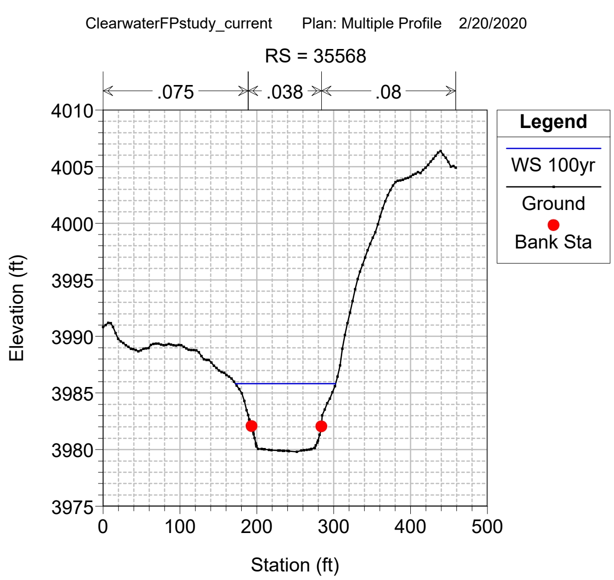
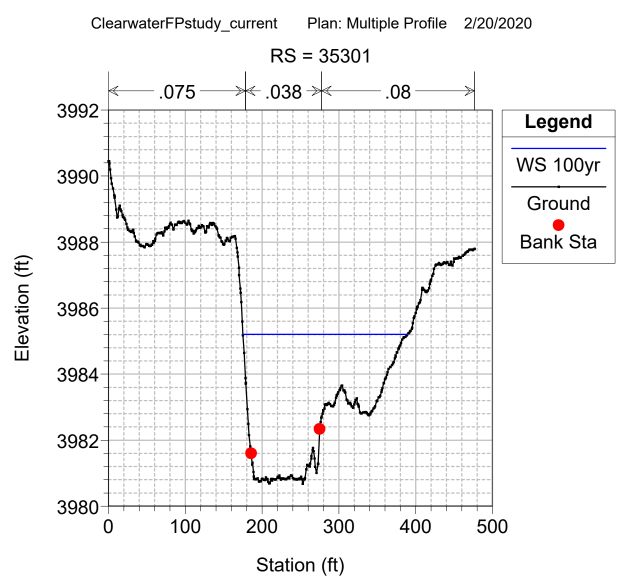
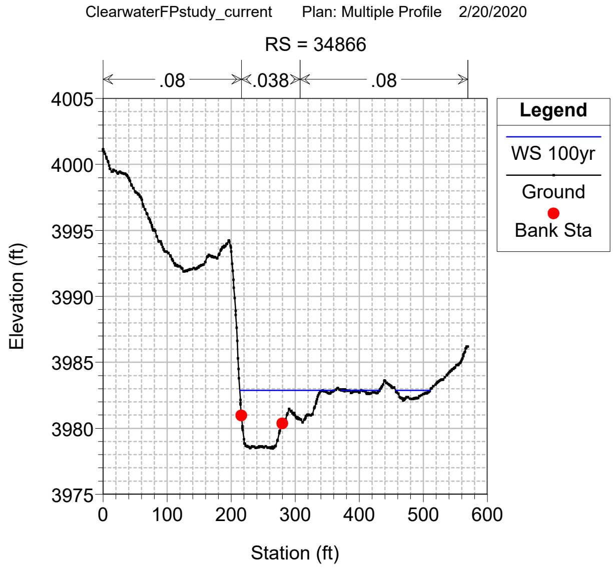
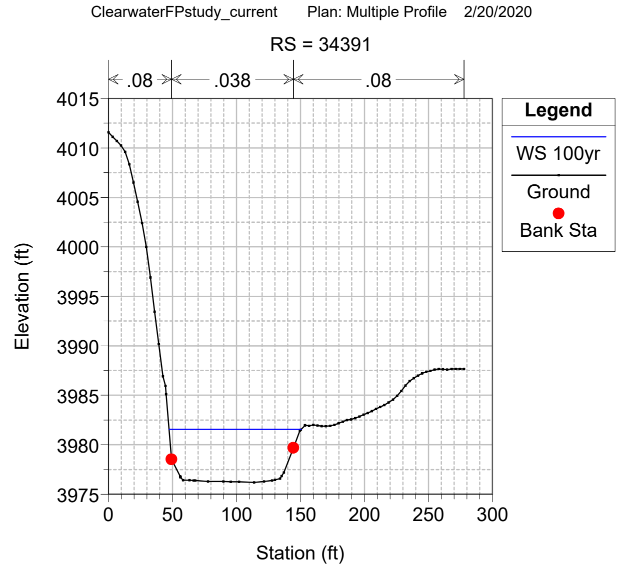
100
200
300
400
500
600
700
Station (ft)
Legend
WS 100yr
Ground
Bank Sta

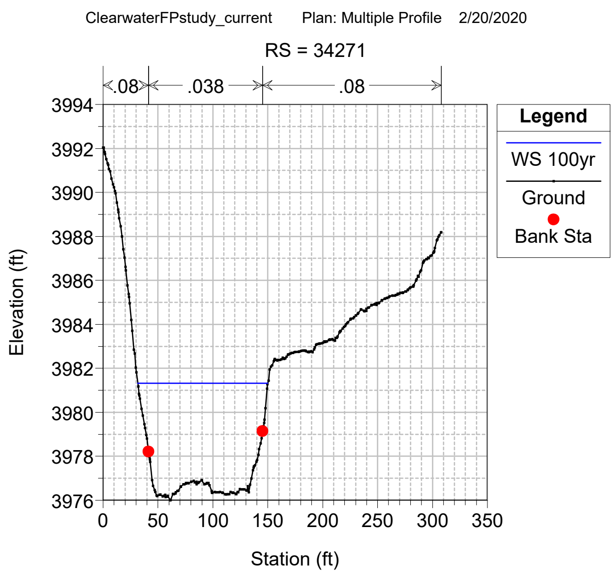

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 36154
.13
.038
.08
Elevation (ft)
4010
4005
4000
3995
3990
3985
3980
0
100
200
300
400
500
600
Station (ft)
Legend
WS 100yr
Ground
Bank Sta

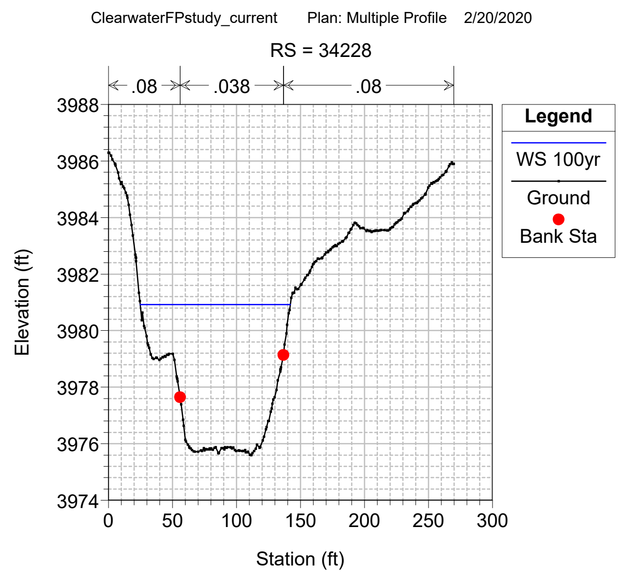

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 35568
.075
.038
.08
Elevation (ft)
4010
4005
4000
3995
3990
3985
3980
3975
0
100
200
300
400
500
Station (ft)
Legend
WS 100yr
Ground
Bank Sta

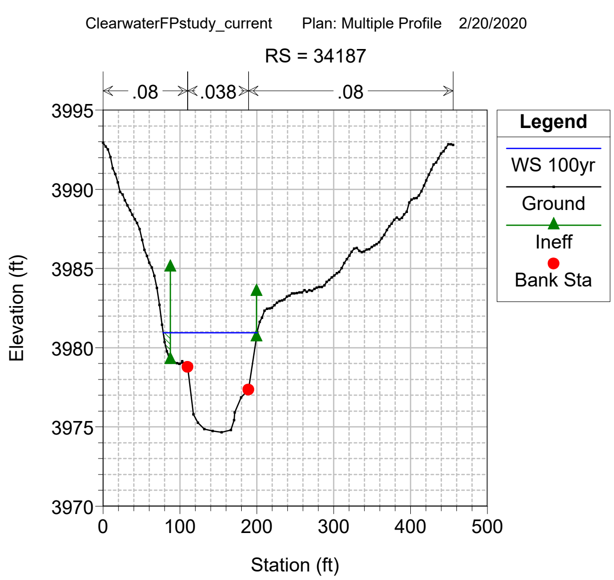

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 35301
.075
.038
.08
Elevation (ft)
3992
3990
3988
3986
3984
3982
3980
0
100
200
300
400
500
Station (ft)
Legend
WS 100yr
Ground
Bank Sta

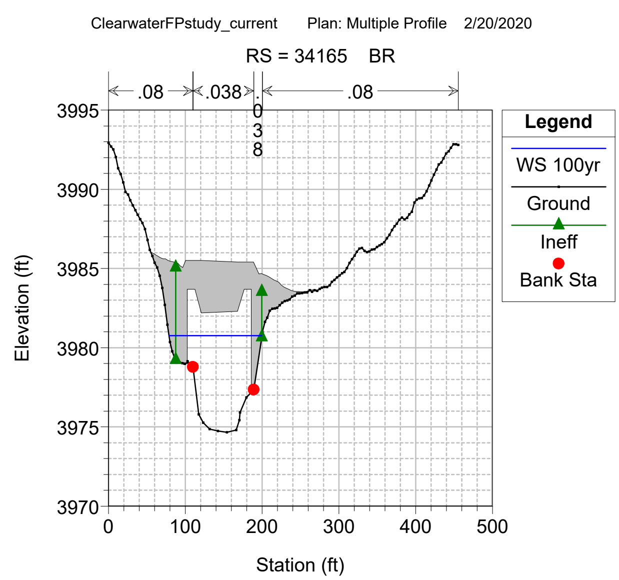

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 34866
.08
.038
.08
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
4005
4000
3995
3990
3985
3980
3975
0 100 200 300 400 500 600
Station (ft)

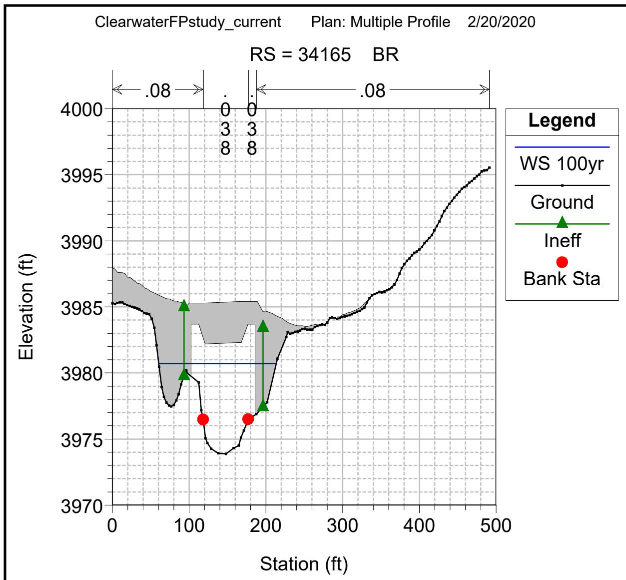

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 34391
.08
.038
.08
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
4015
4010
4005
4000
3995
3990
3985
3980
3975
0 50 100 150 200 250 300
Station (ft)

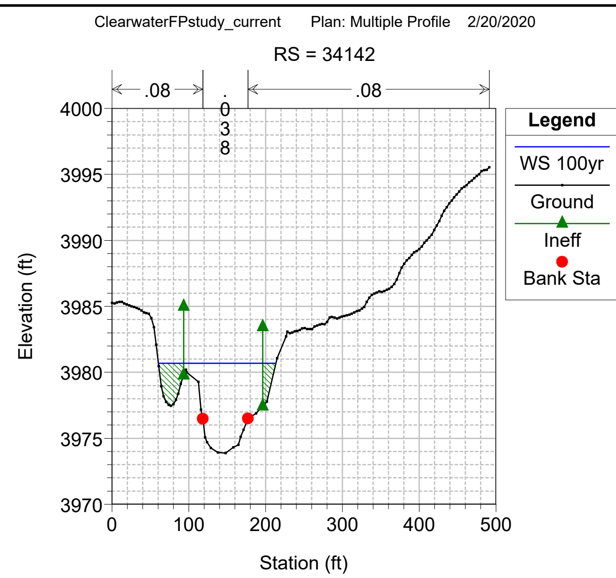

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 34271
.08
.038
.08
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
3994
3992
3990
3988
3986
3984
3982
3980
3978
3976
0 50 100 150 200 250 300 350
Station (ft)

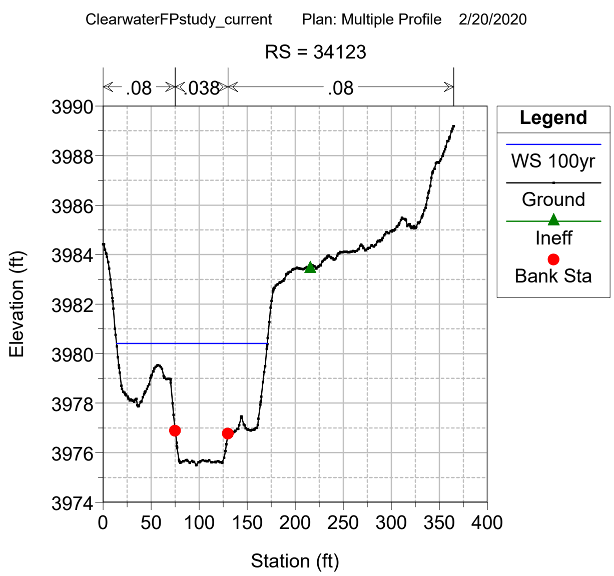

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 34228
.08
.038
.08
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
3988
3986
3984
3982
3980
3978
3976
3974
0 50 100 150 200 250 300
Station (ft)

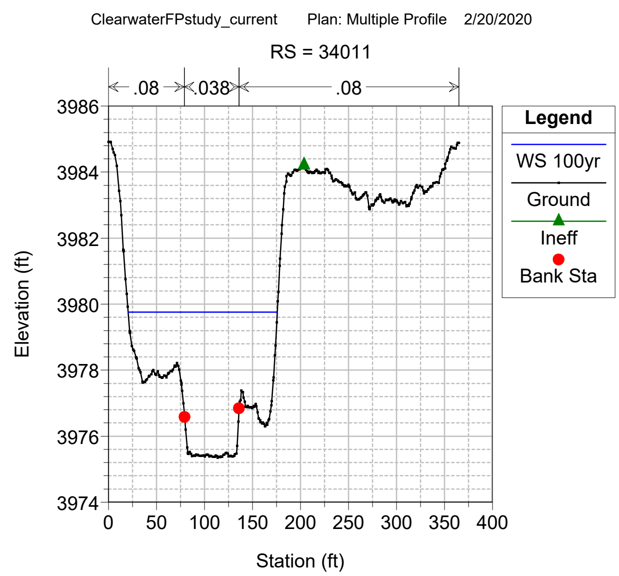

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 34187
.08
.038
.08
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
3995
3990
3985
3980
3975
3970
0 100 200 300 400 500
Station (ft)

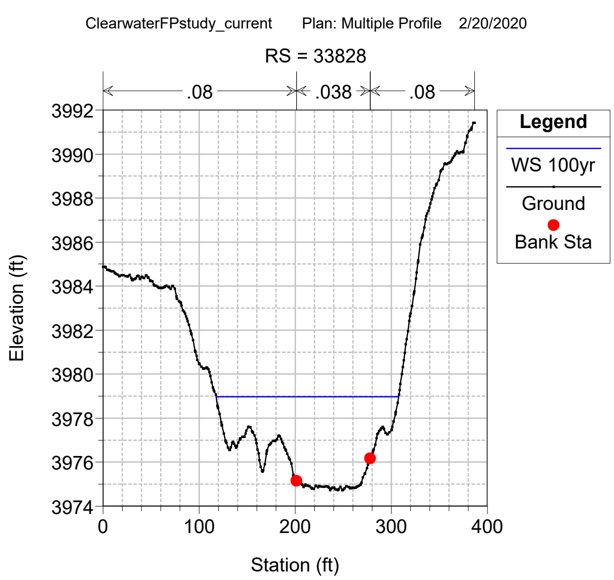

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 34165 BR
.08
.038
.038
.08
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
3995
3990
3985
3980
3975
3970
0 100 200 300 400 500
Station (ft)

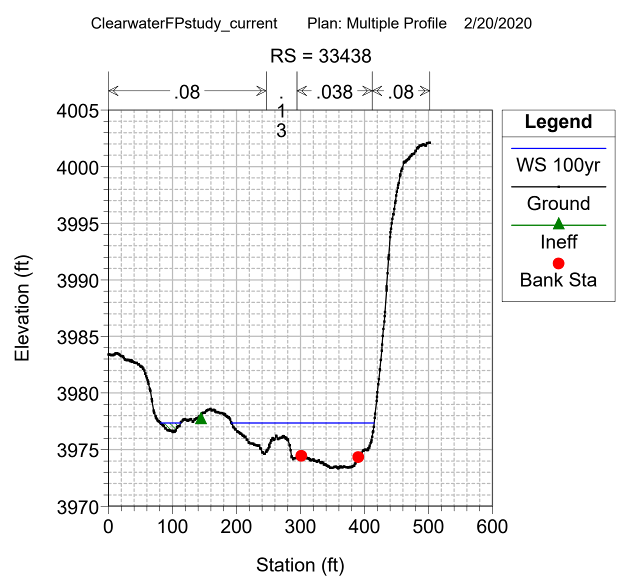

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 34165 BR
.08
.038
.038
.08
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Ineff
Bank Sta

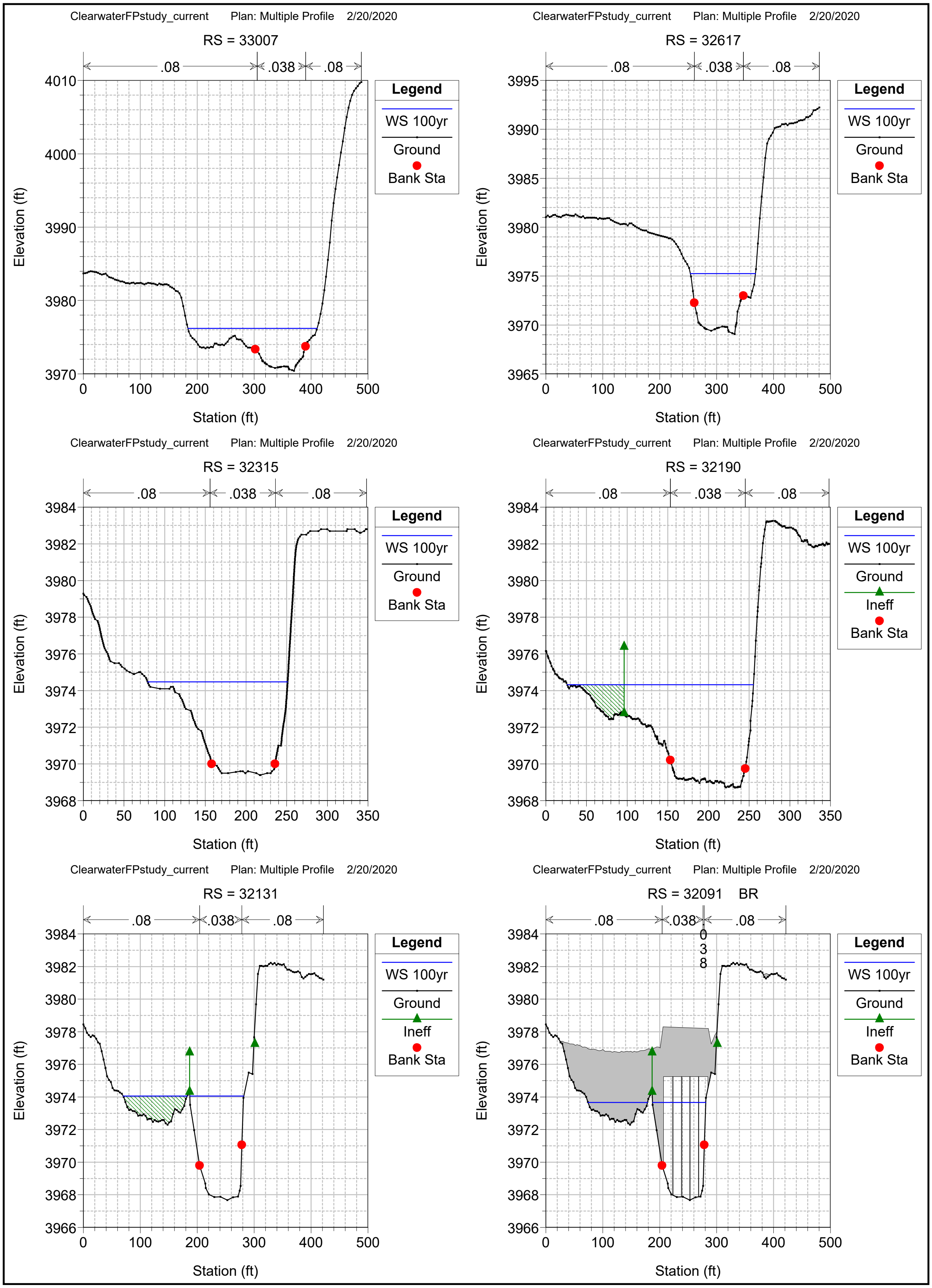

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 34142
.08
.038
.08
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Ineff
Bank Sta

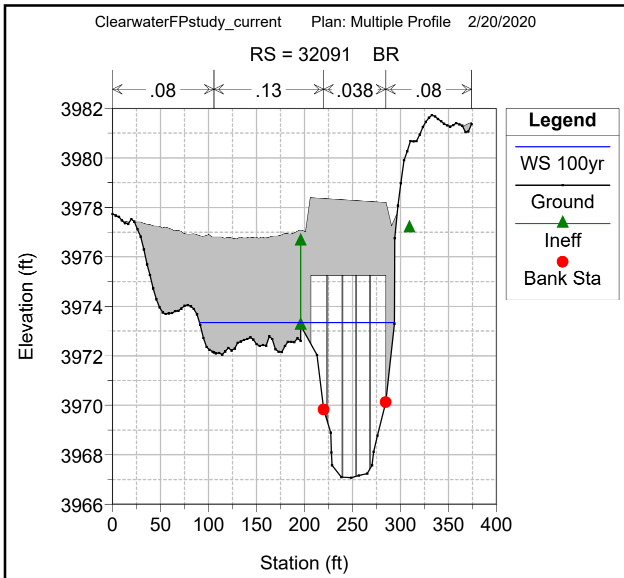

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 34123
.08
.038
.08
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Ineff
Bank Sta

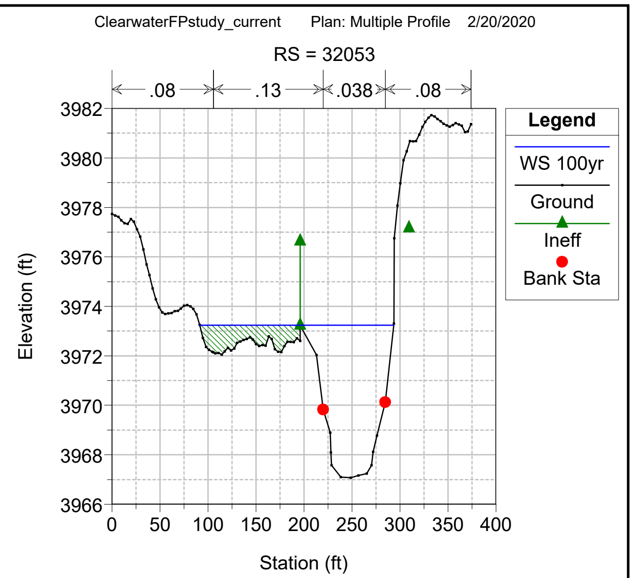

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 34011
.08
.038
.08
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Ineff
Bank Sta

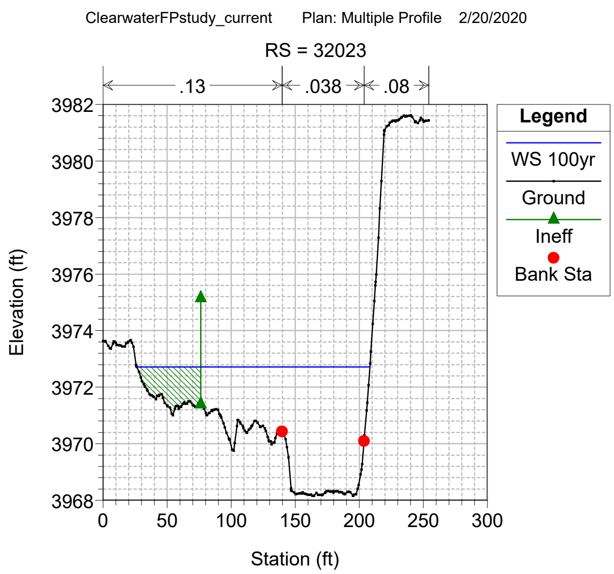

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 33828
.08
.038
.08
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Bank Sta

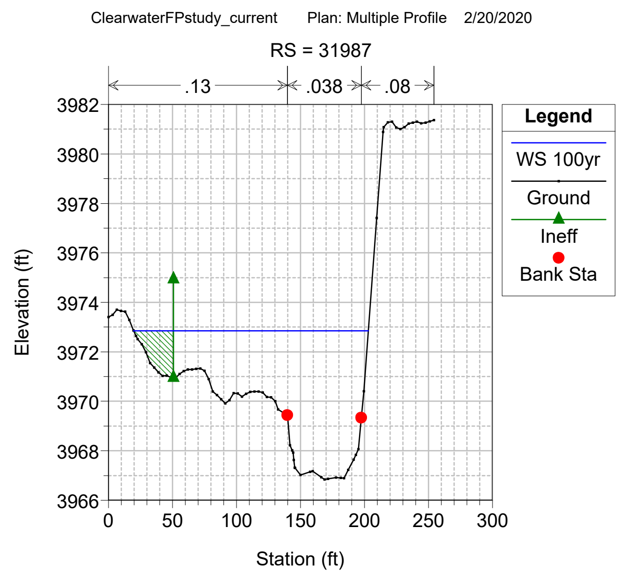

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 33438
.08
.13
.038
.08
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Ineff
Bank Sta

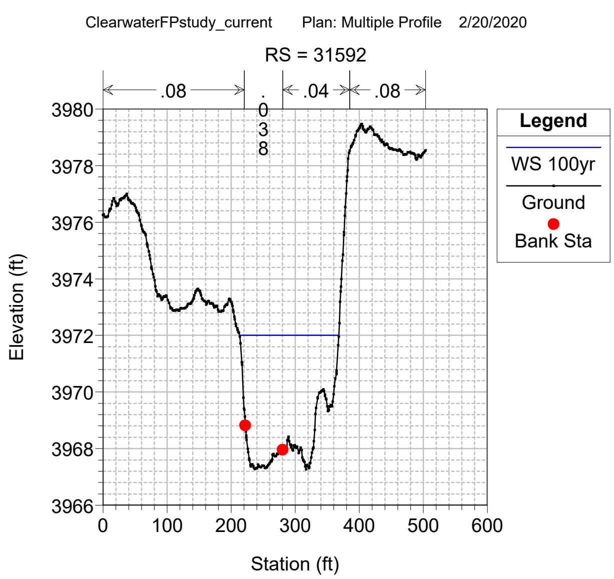

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 33007
.08 .038 .08
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 32617
.08 .038 .08
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 32315
.08 .038 .08
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 32190
.08 .038 .08
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 32131
.08 .038 .08
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 32091 BR
.08 .038 .08
038
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

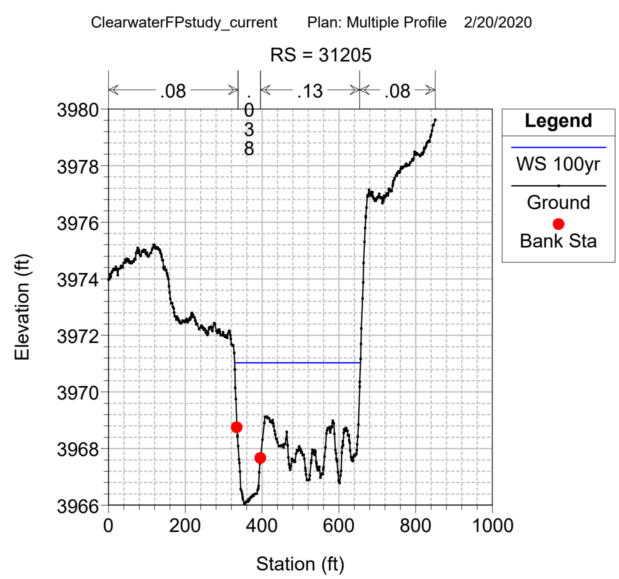

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 32091 BR
.08
.13
.038
.08
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Ineff
Bank Sta

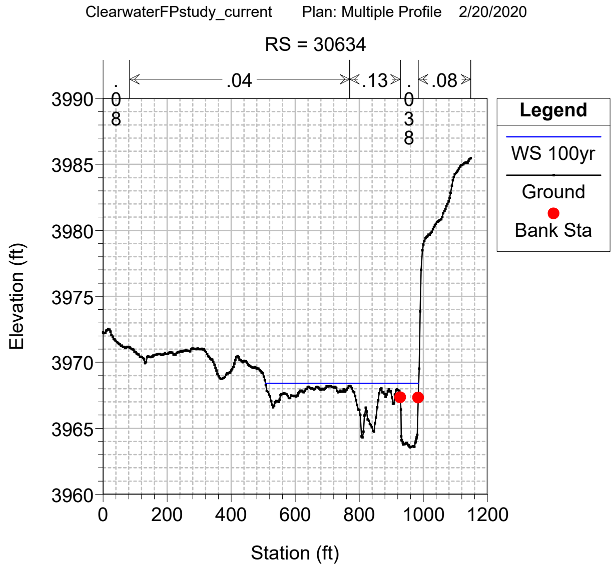

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 32053
.08
.13
.038
.08
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Ineff
Bank Sta

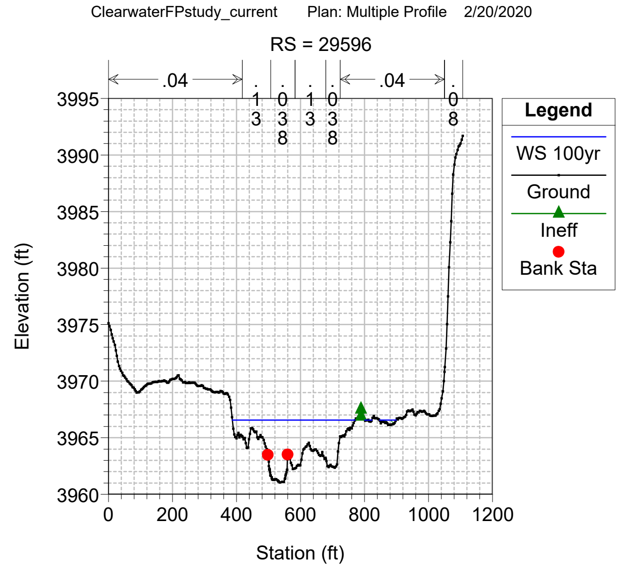

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 32023
.13
.038
.08
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Ineff
Bank Sta

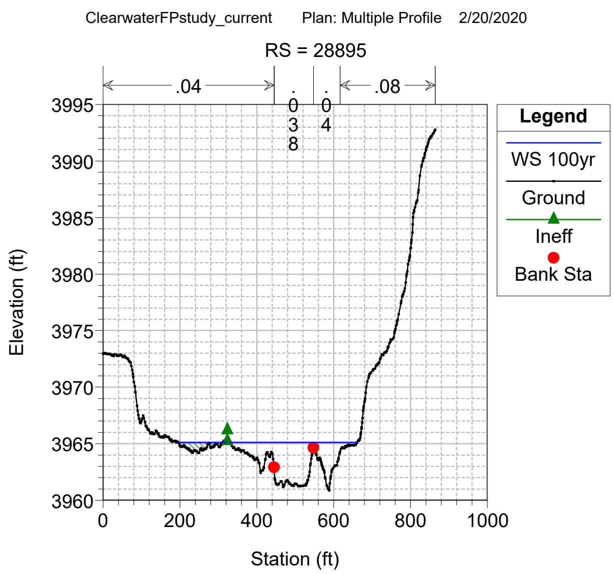

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 31987
.13
.038
.08
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Ineff
Bank Sta

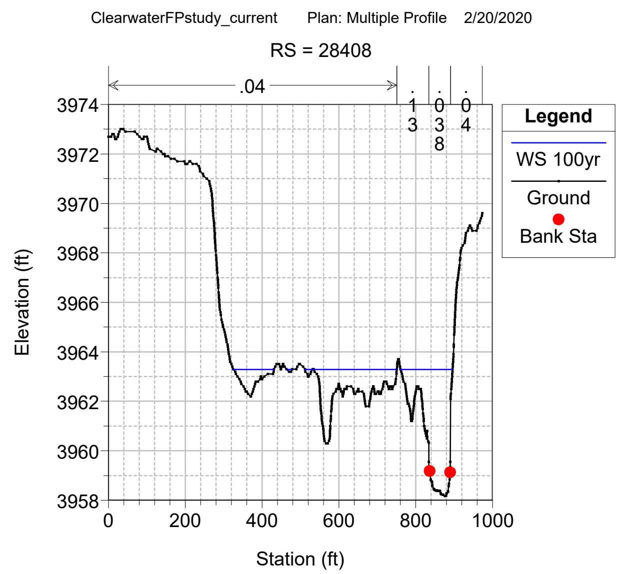

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 31592
.08
.038
.04
.08
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Bank Sta

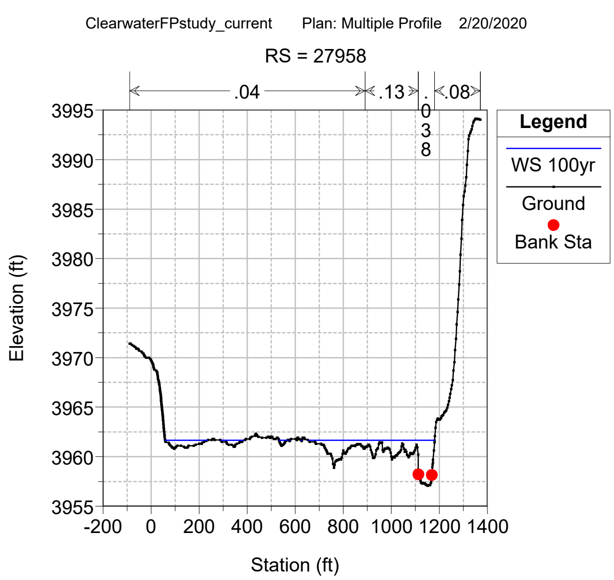

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 31205
.08
.038
.13
.08
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Bank Sta

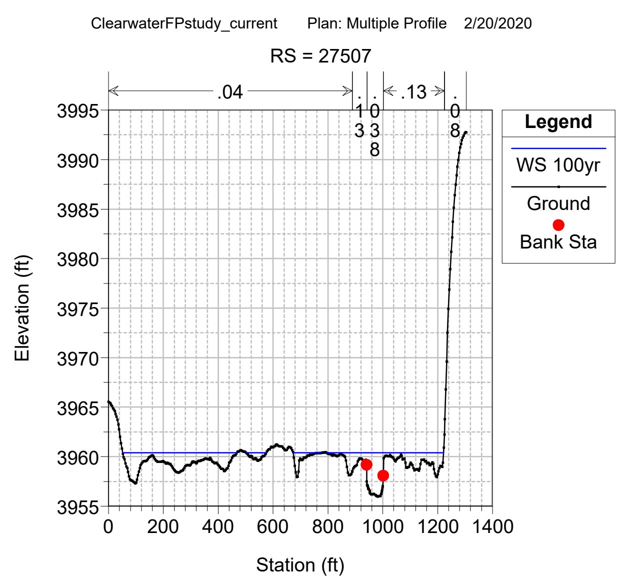

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 30634
.04
.13
.08
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Bank Sta

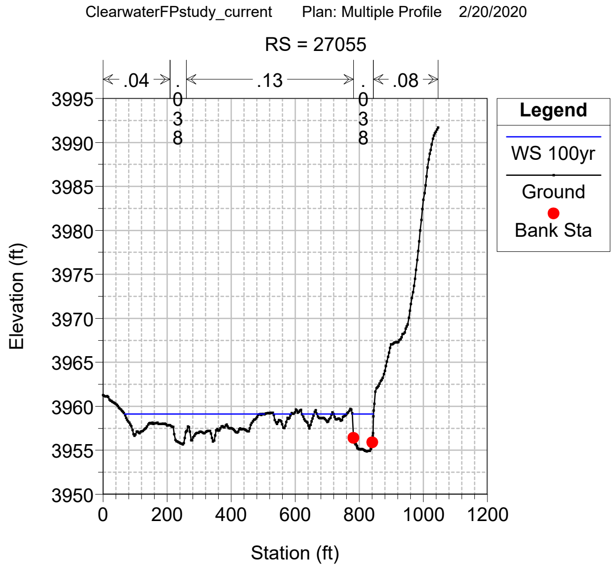

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 29596
.04
.04
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Ineff
Bank Sta


ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 28895
.04
.08
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Ineff
Bank Sta

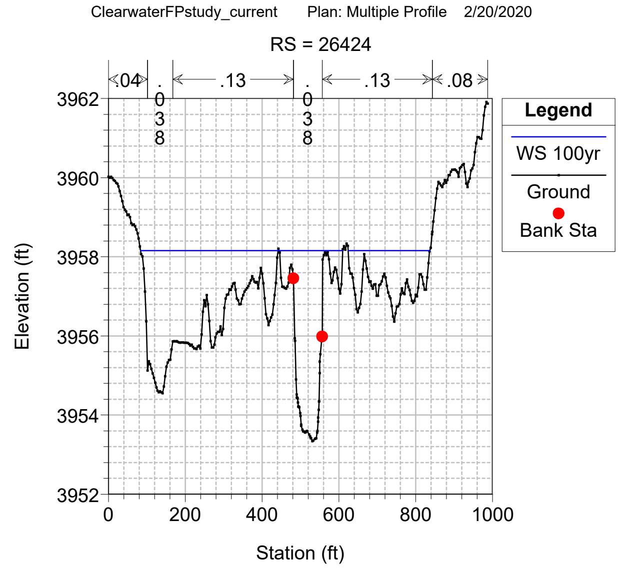

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 28408
.04
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Bank Sta


ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 27958
.04
.13
.08
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Bank Sta

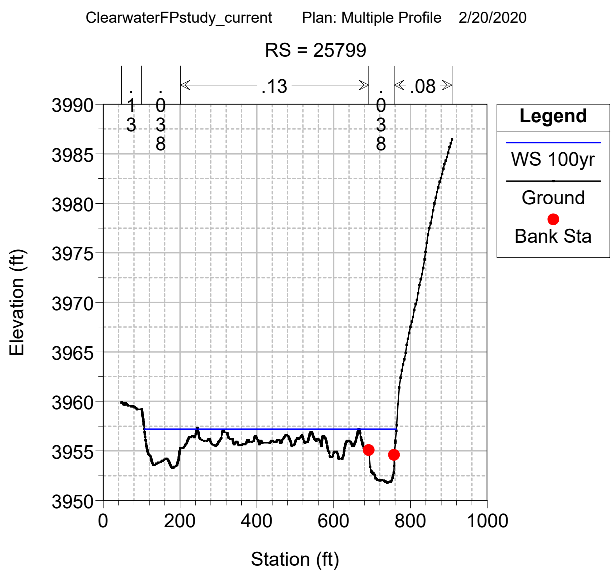

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 27507
.04
.13
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Bank Sta



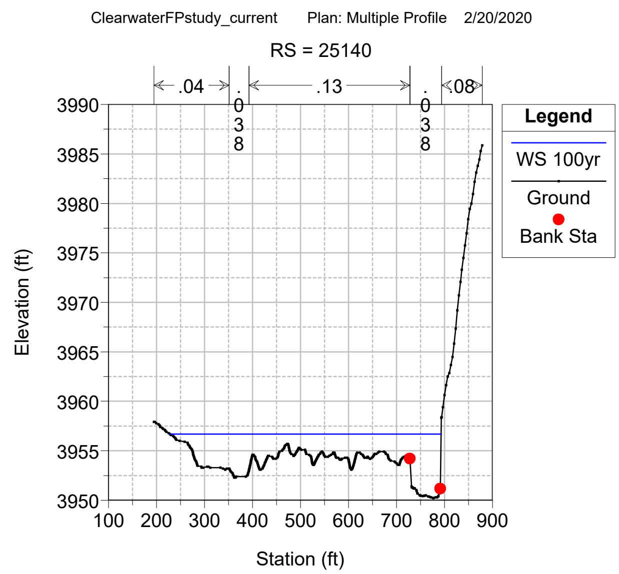
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 27055
.04
.13
.08
.038
.038
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)



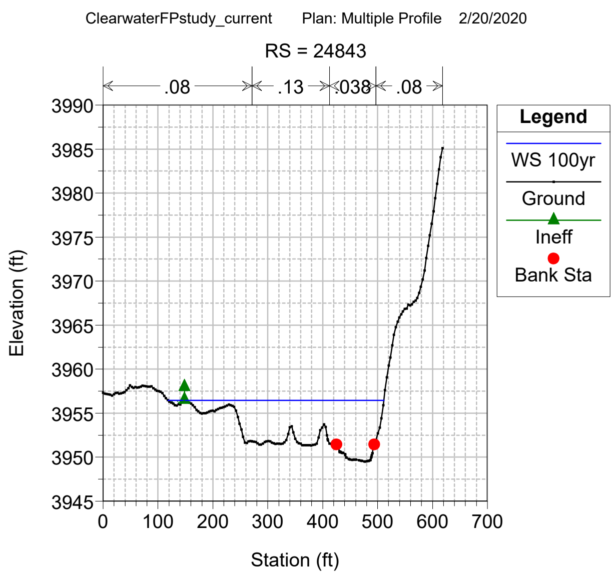
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 26424
.04
.13
.13
.08
.038
.038
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)



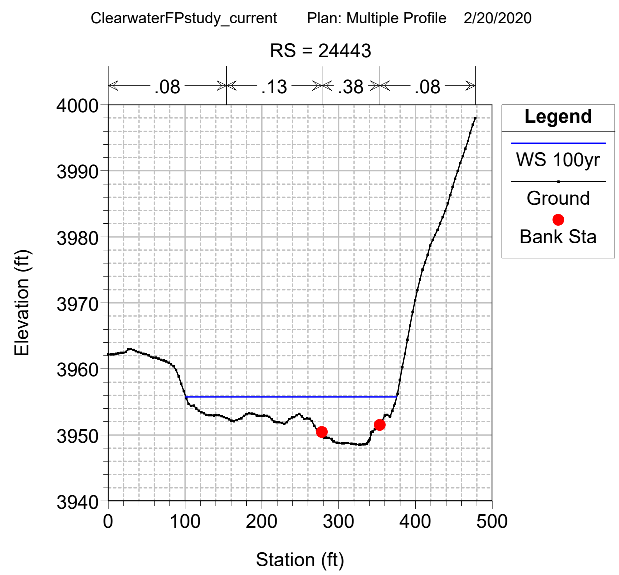
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 25799
.13
.038
.13
.038
.08
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)



ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 25140
.04
.038
.13
.038
.08
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)



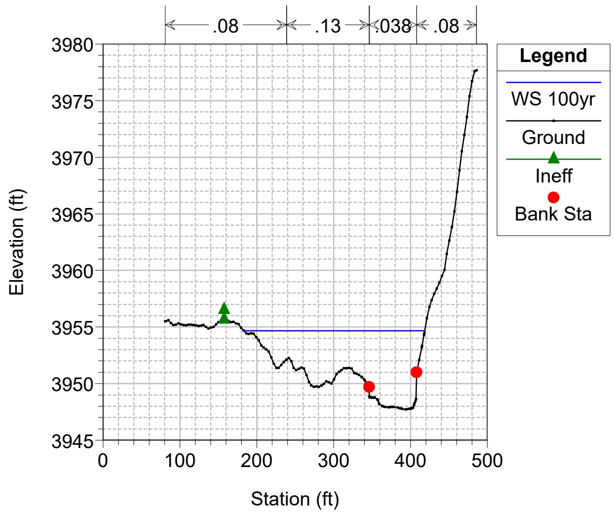
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 24843
.08
.13
.038
.08
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)



ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 24443
.08
.13
.38
.08
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

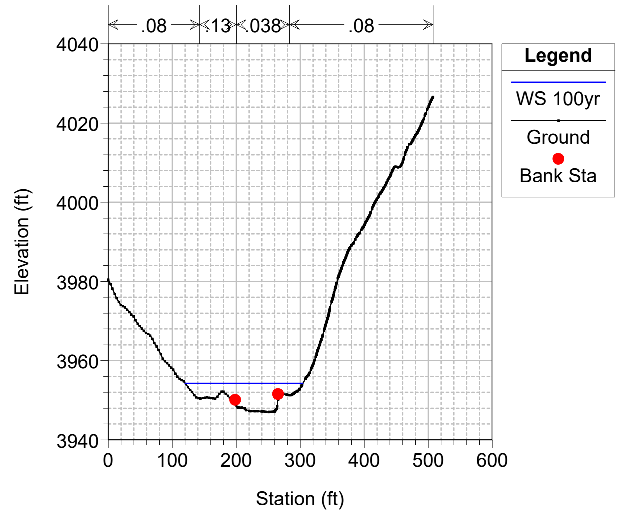
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020

RS = 24108



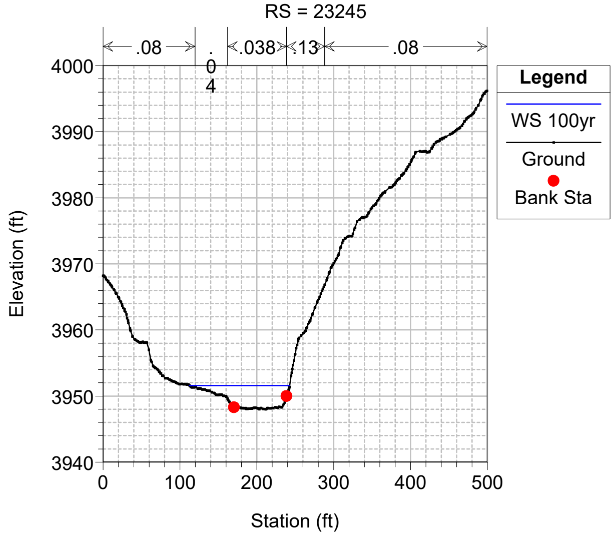
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020

RS = 23834



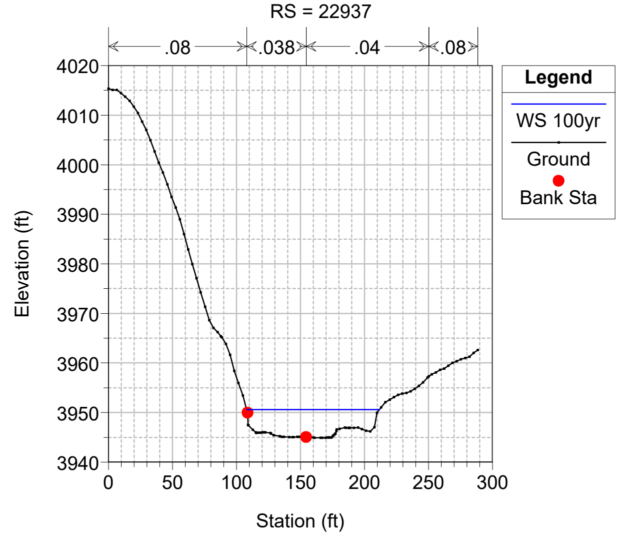
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020

RS = 23245



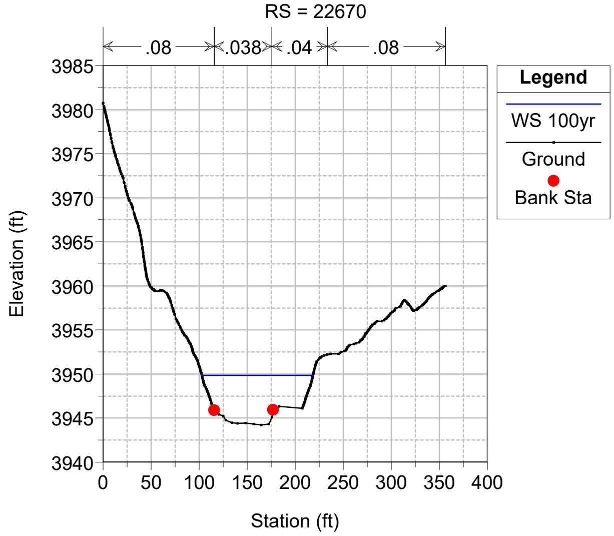
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020

RS = 22937



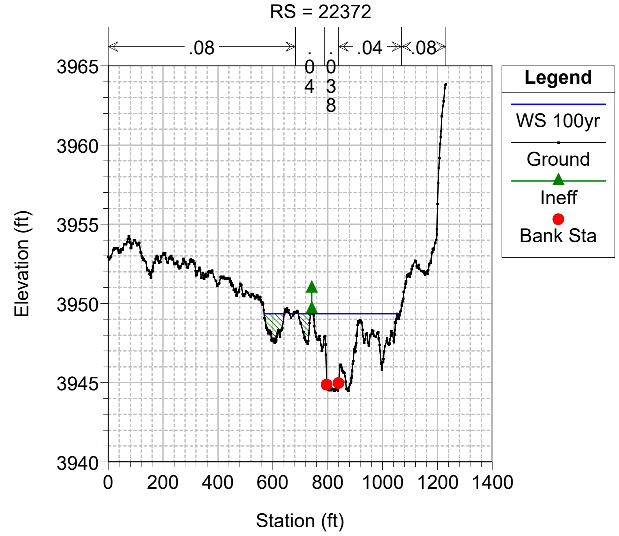
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020

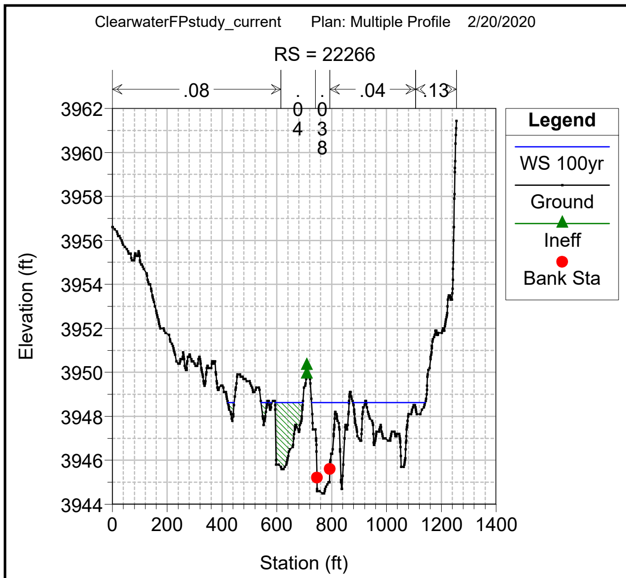
RS = 22670

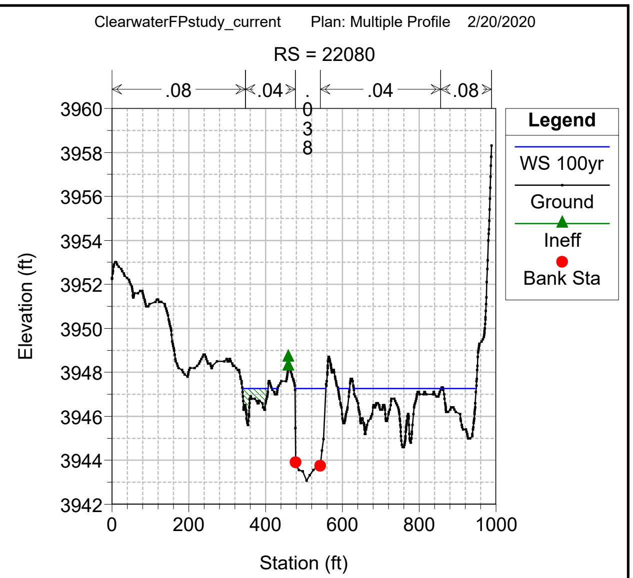


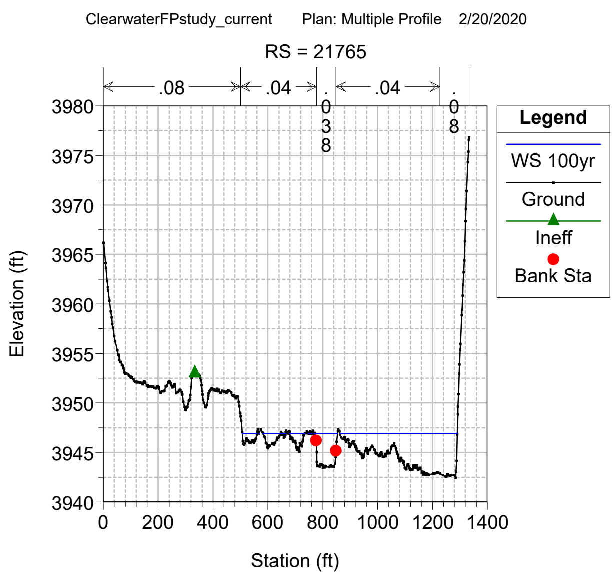
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020

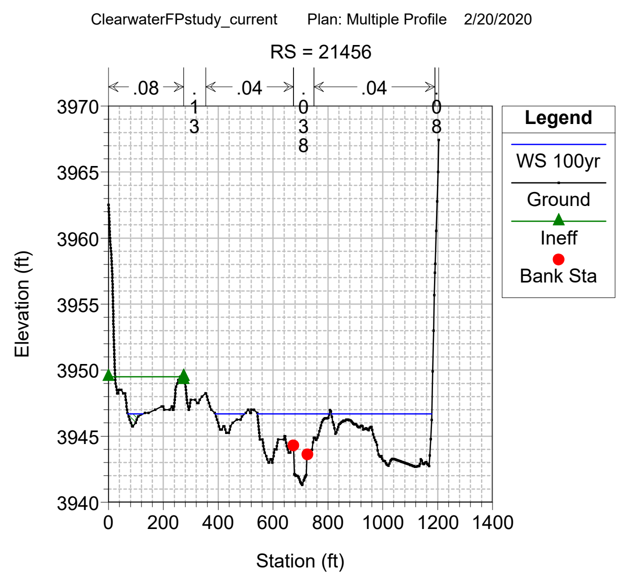
RS = 22372

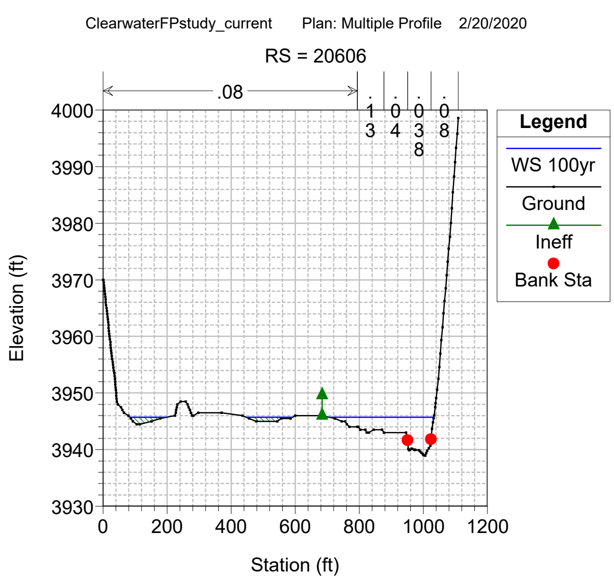


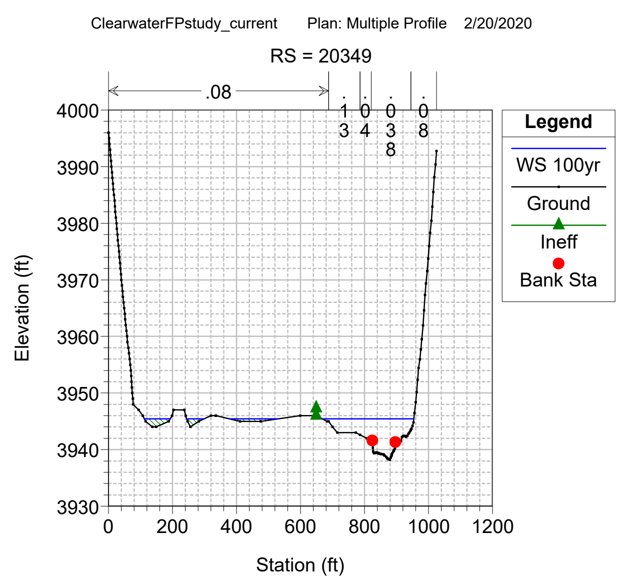

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 22266
.08
.04
.13
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 22080
.08
.04
.04
.08
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 21765
.08
.04
.04
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 21456
.08
.04
.04
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 20606
.08
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 20349
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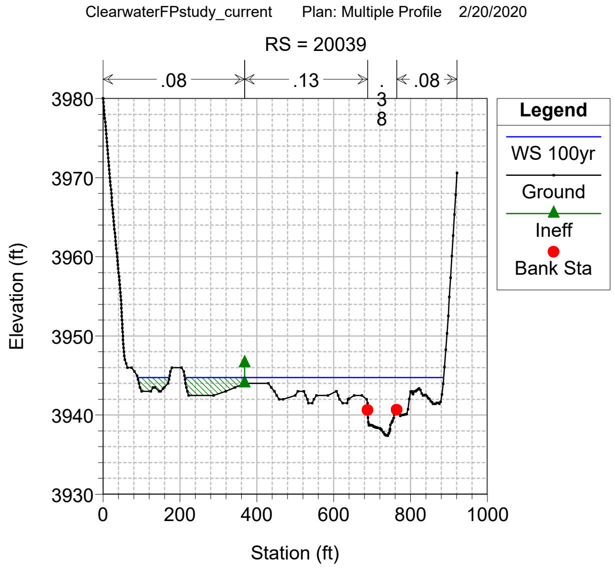
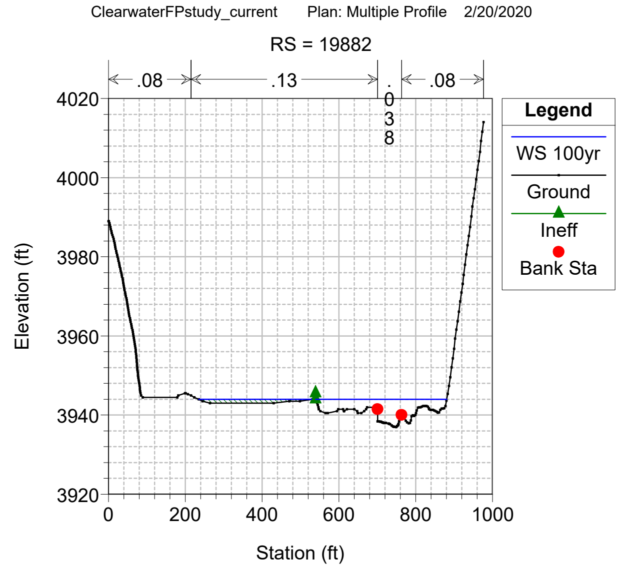
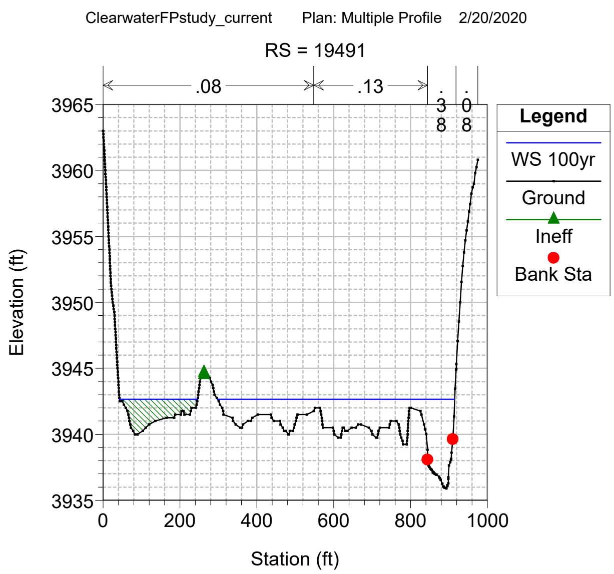
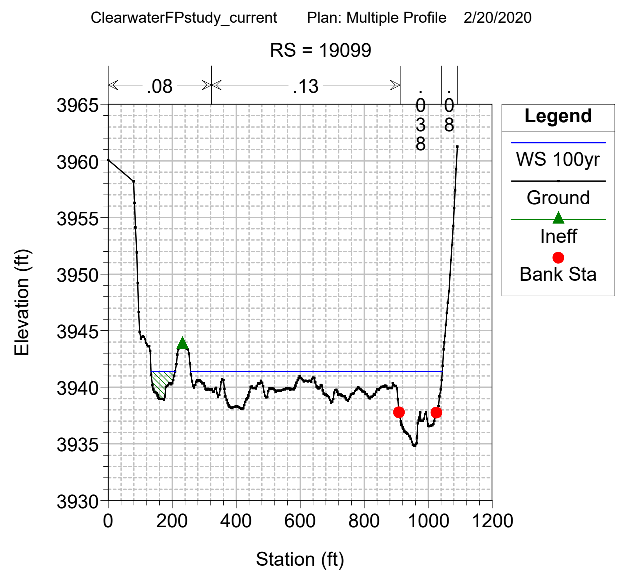
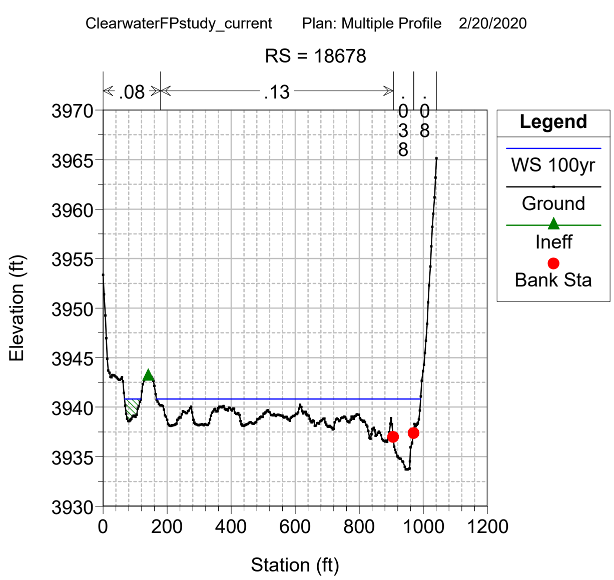
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

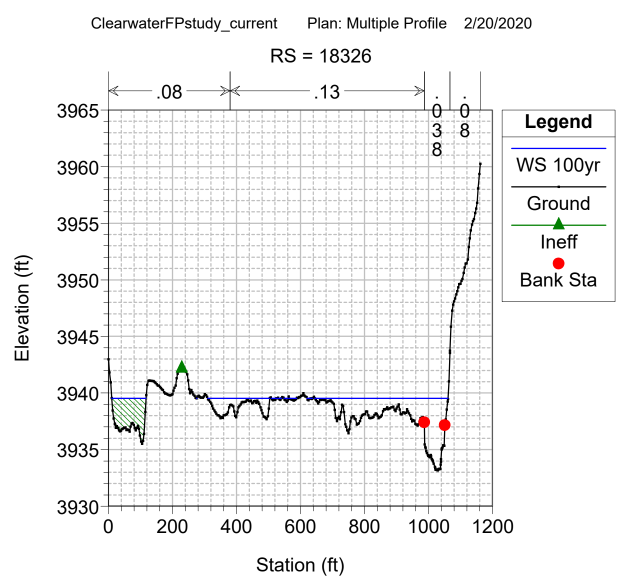

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 20039
.08
.13
.08
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 19882
.08
.13
.08
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 19491
.08
.13
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

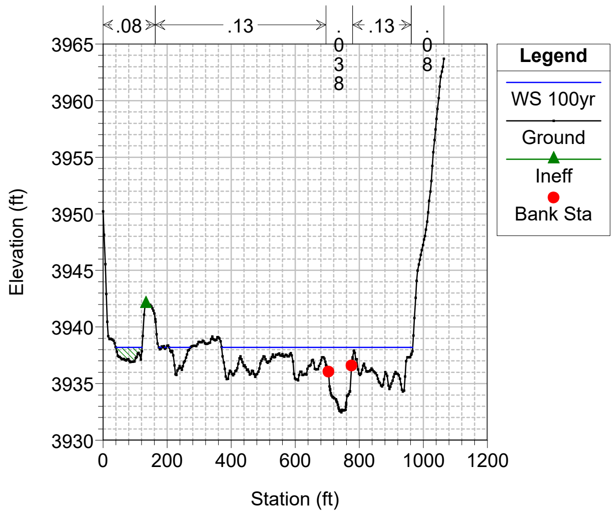

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 19099
.08
.13
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 18678
.08
.13
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 18326
.08
.13
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

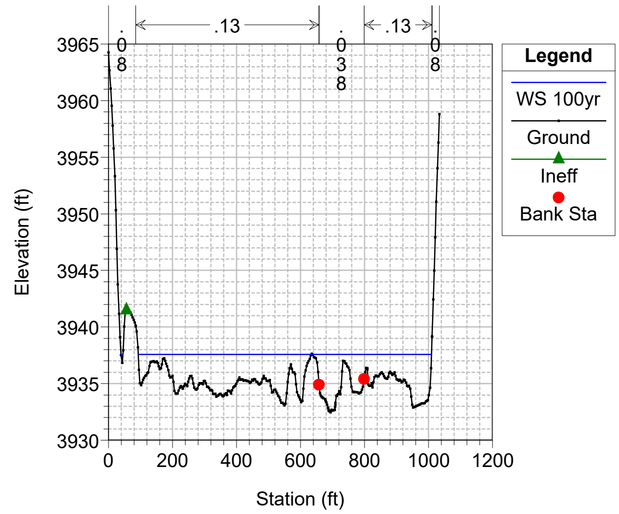
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020

RS = 17876



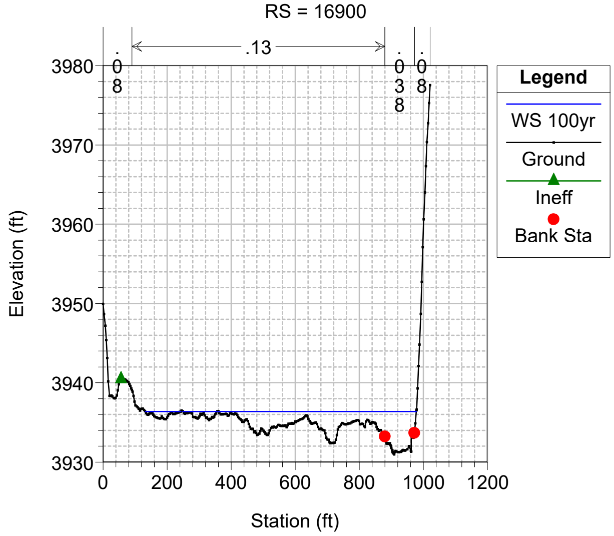
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020

RS = 17491



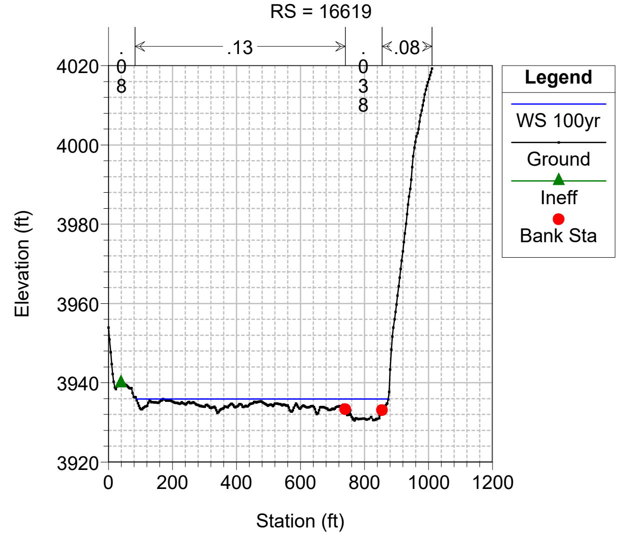
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020

RS = 16900



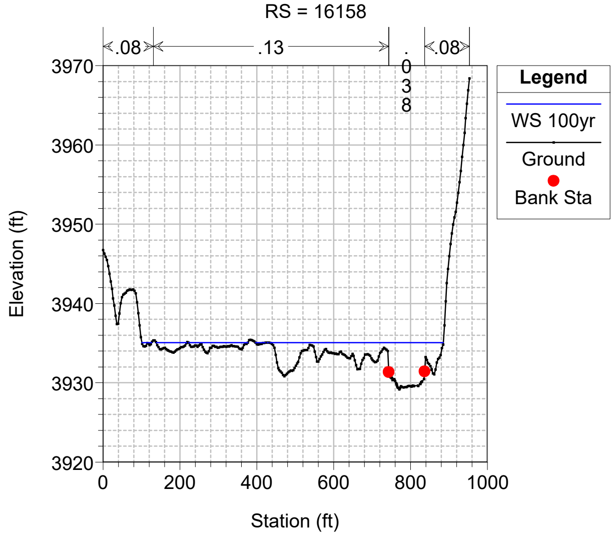
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020

RS = 16619



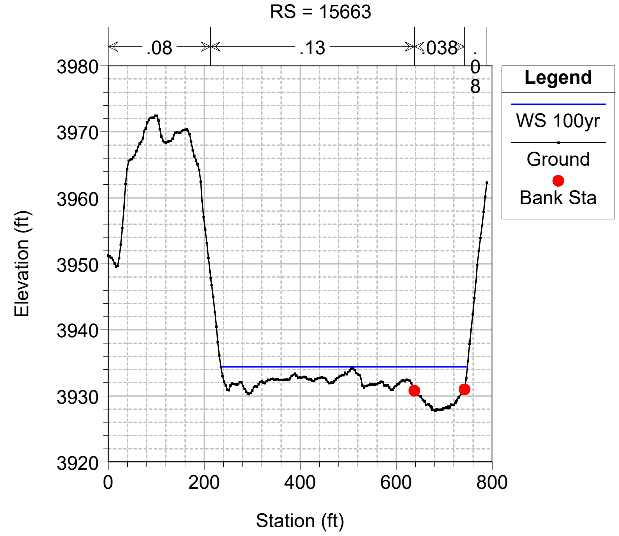
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020

RS = 16158



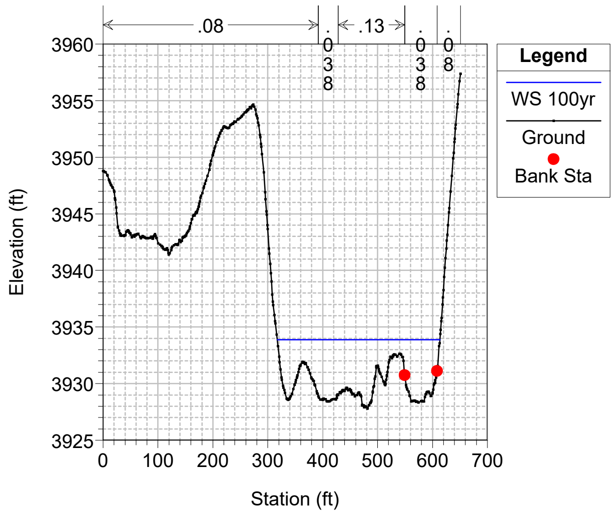
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020

RS = 15663



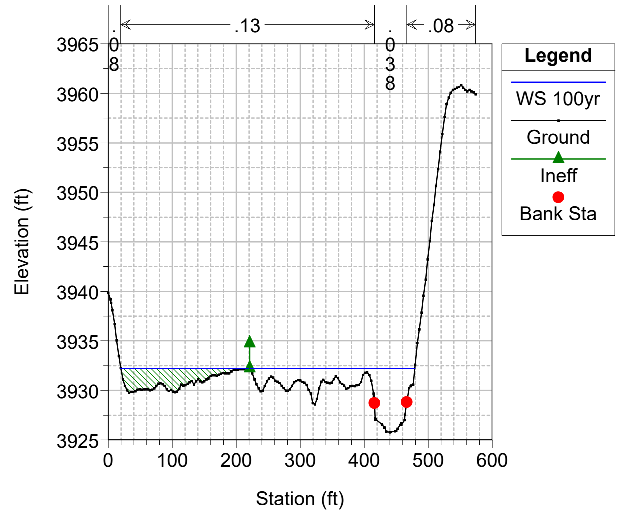
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020

RS = 15238



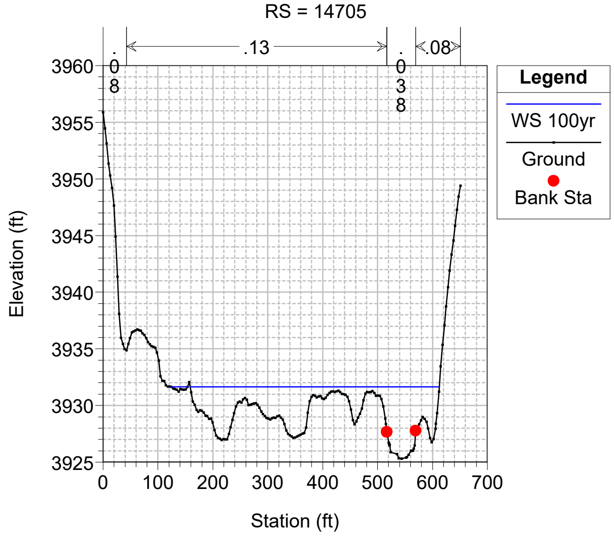
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020

RS = 14989



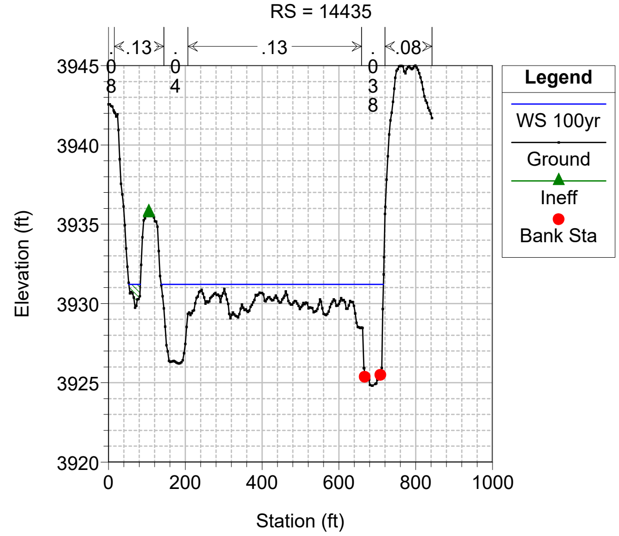
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020

RS = 14705



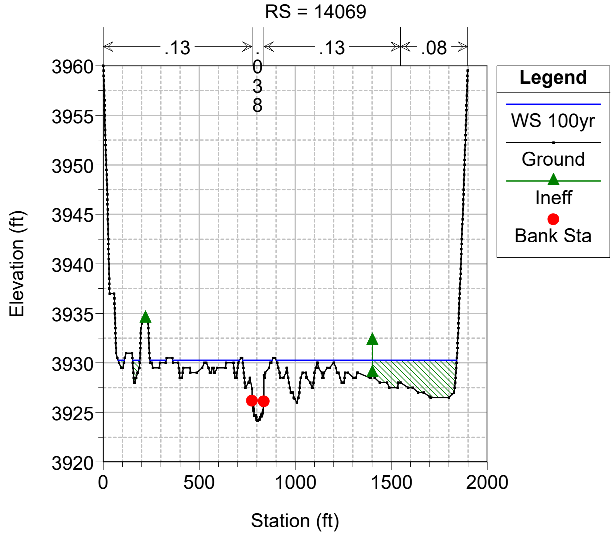
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020

RS = 14435



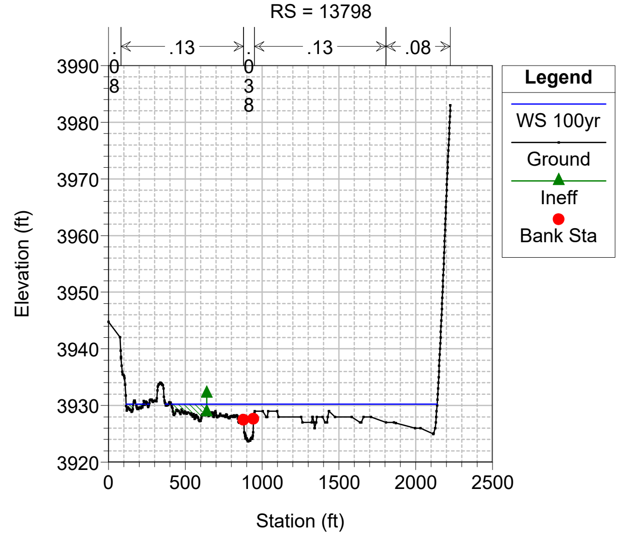
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020

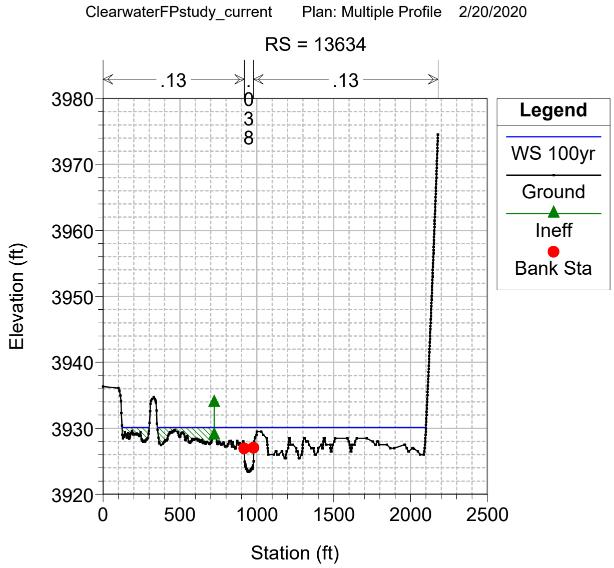
RS = 14069

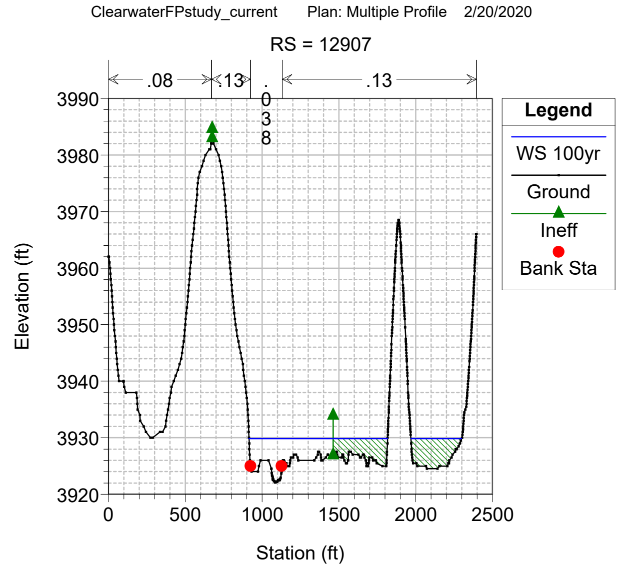


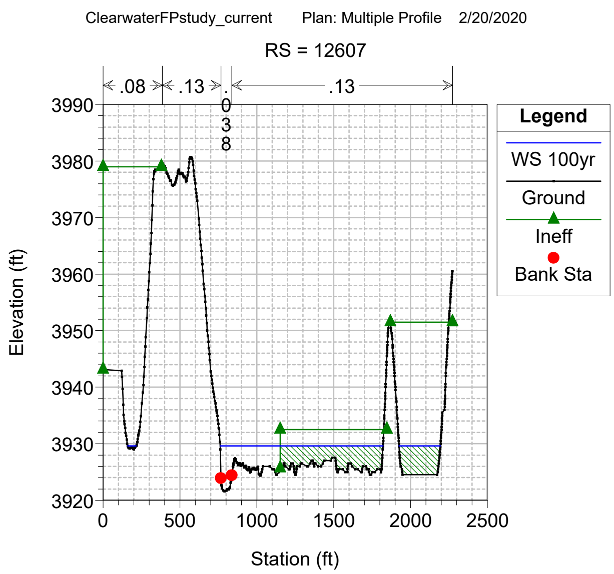
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020

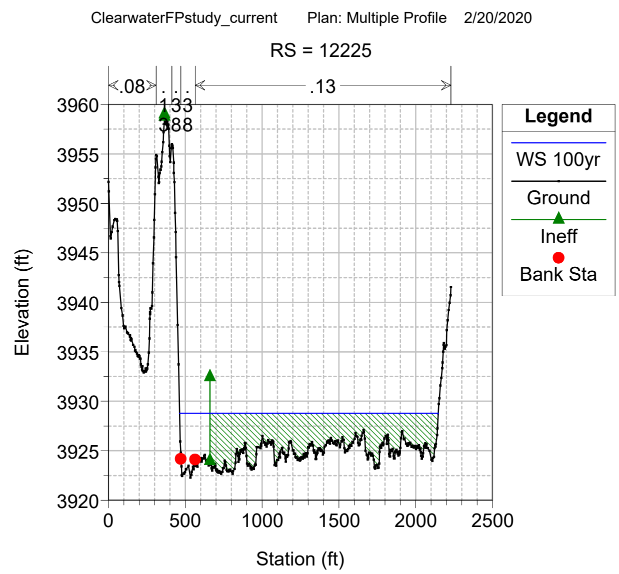
RS = 13798

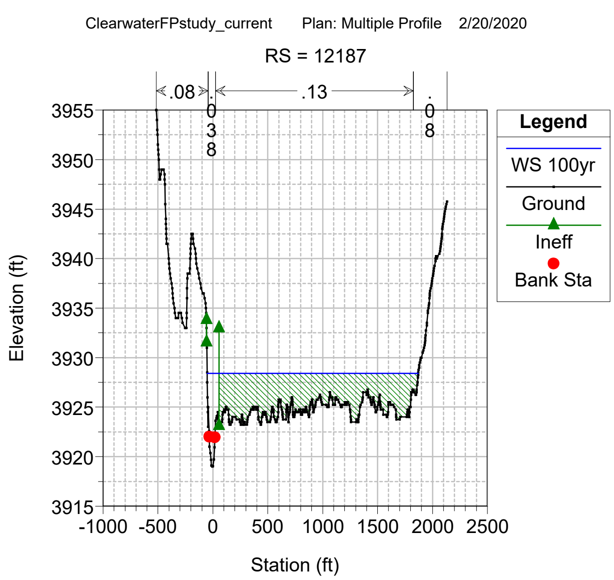


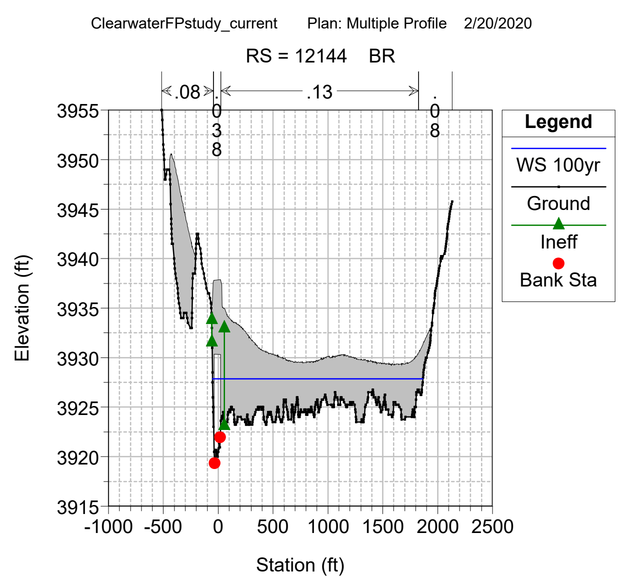

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 13634
.13
.038
.13
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3920
3930
3940
3950
3960
3970
3980
0
500
1000
1500
2000
2500

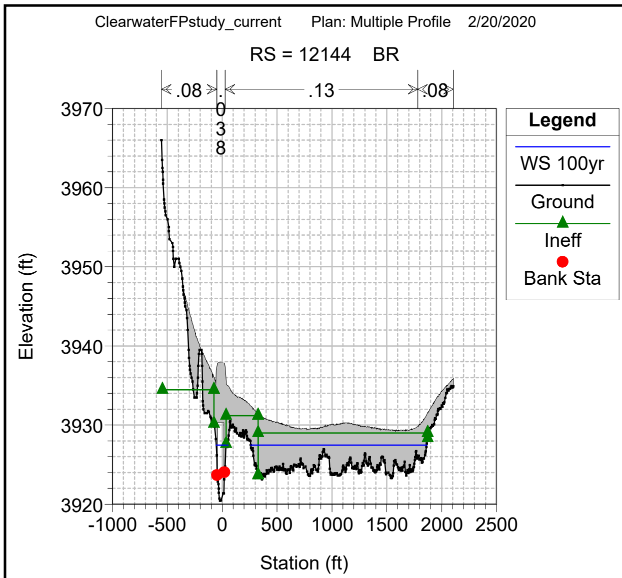

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 12907
.08
.13
.038
.13
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3920
3930
3940
3950
3960
3970
3980
3990
0
500
1000
1500
2000
2500

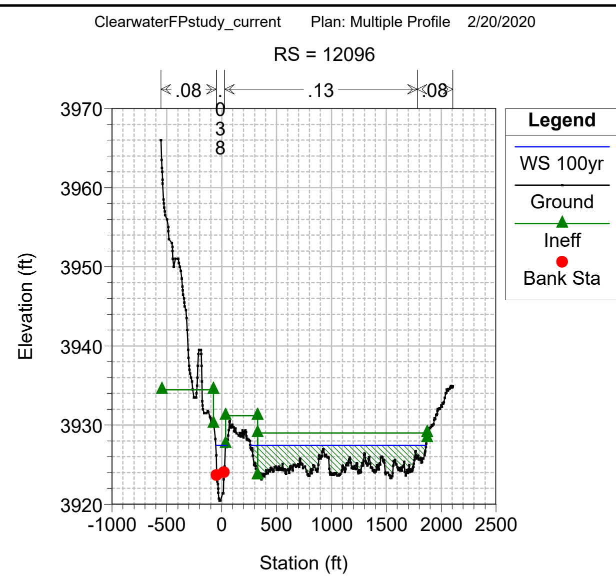

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 12607
.08
.13
.038
.13
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3920
3930
3940
3950
3960
3970
3980
3990
0
500
1000
1500
2000
2500

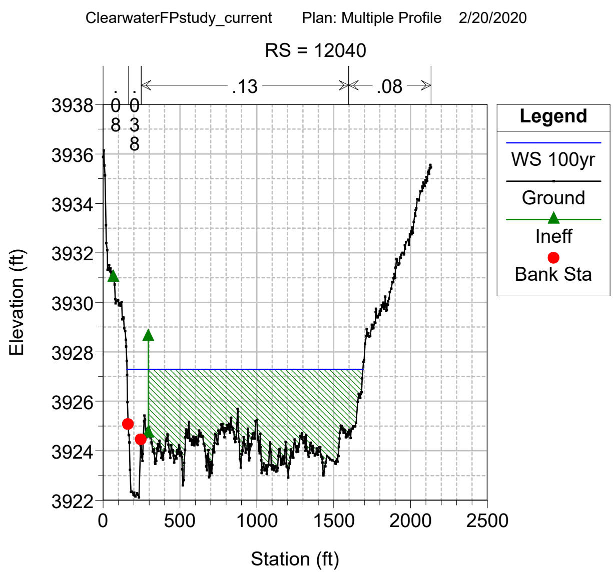

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 12225
.08
.038
.13
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3920
3925
3930
3935
3940
3945
3950
3955
3960
0
500
1000
1500
2000
2500

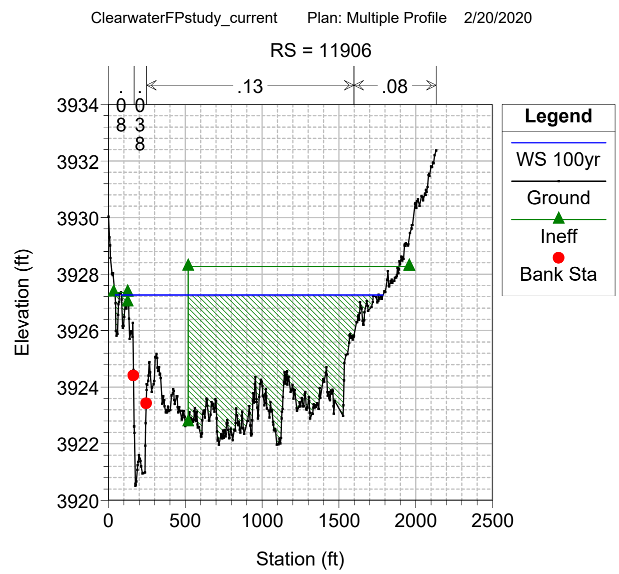

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 12187
.08
.038
.13
.08
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3915
3920
3925
3930
3935
3940
3945
3950
3955
-1000
-500
0
500
1000
1500
2000
2500

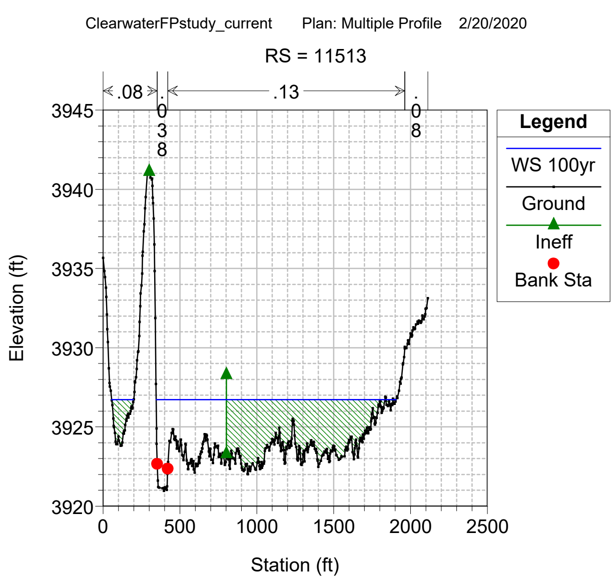

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 12144 BR
.08
.038
.13
.08
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3915
3920
3925
3930
3935
3940
3945
3950
3955
-1000
-500
0
500
1000
1500
2000
2500

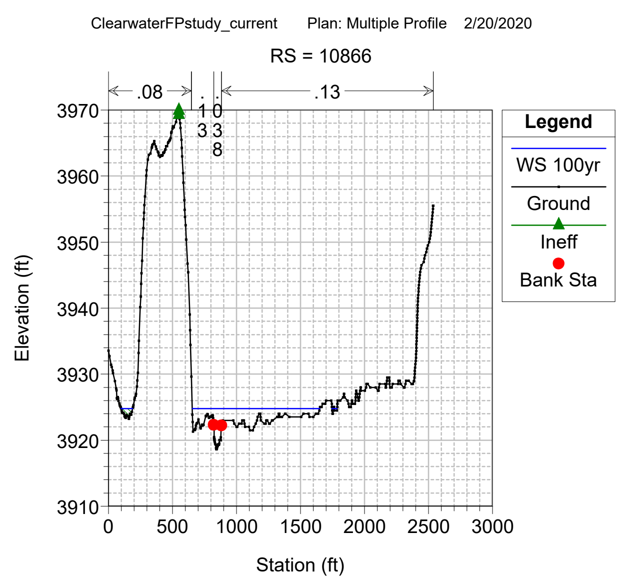

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 12144 BR
.08
.13
.08
.038
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Ineff
Bank Sta

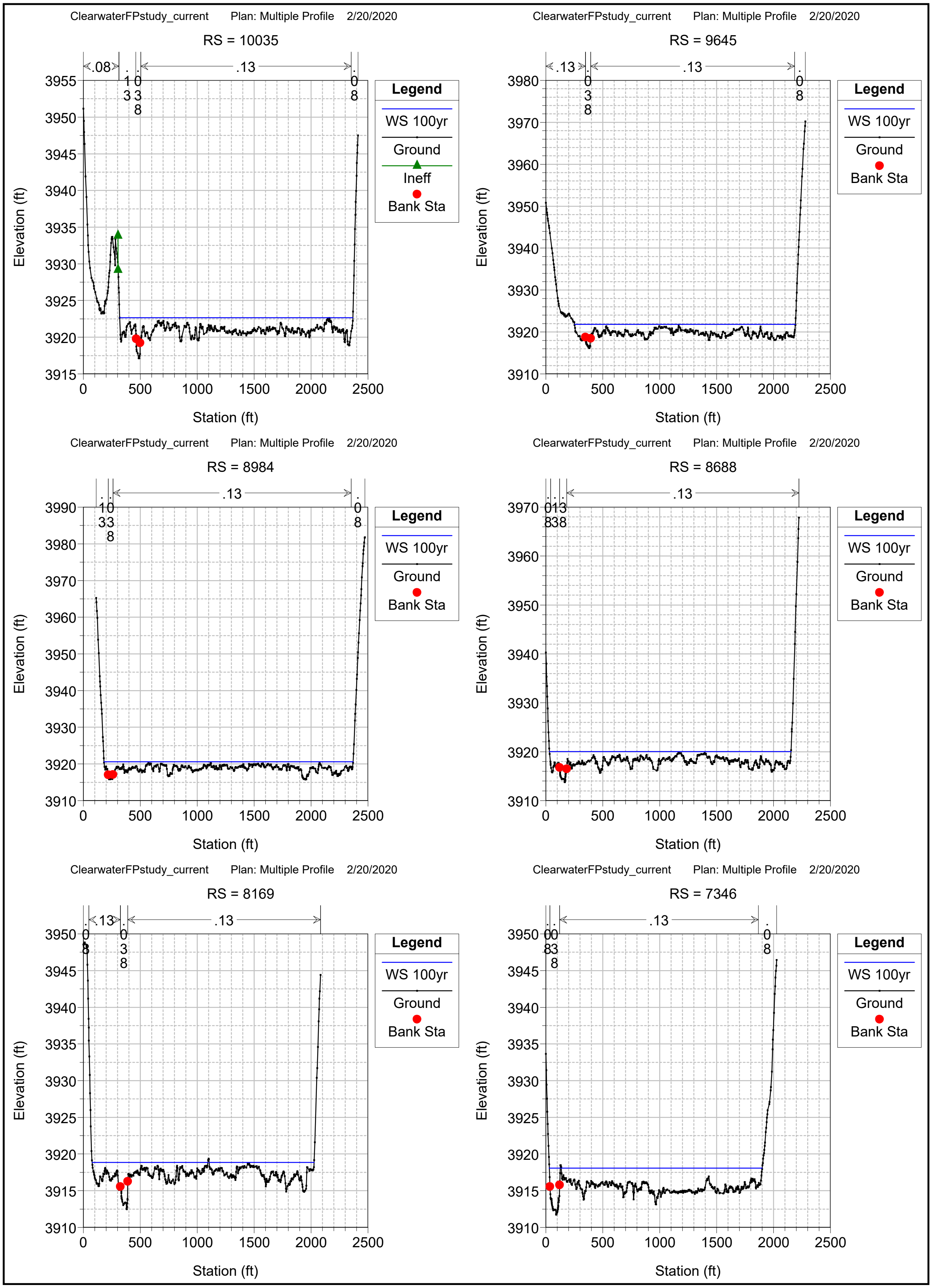

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 12096
.08
.13
.08
.038
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Ineff
Bank Sta

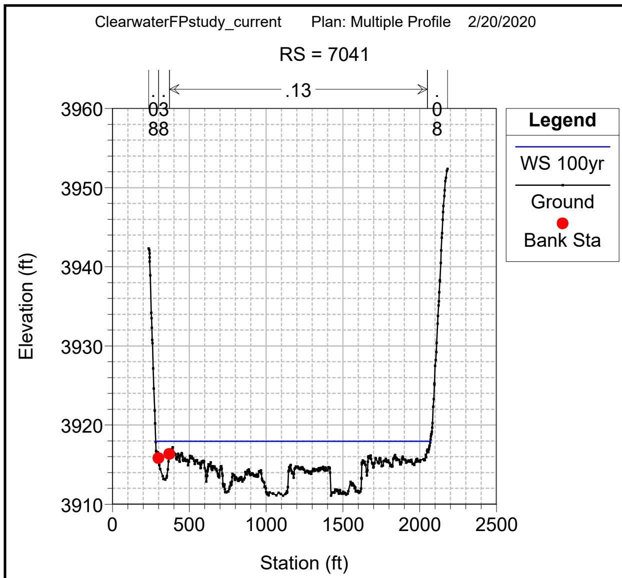

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 12040
.08
.038
.13
.08
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Ineff
Bank Sta

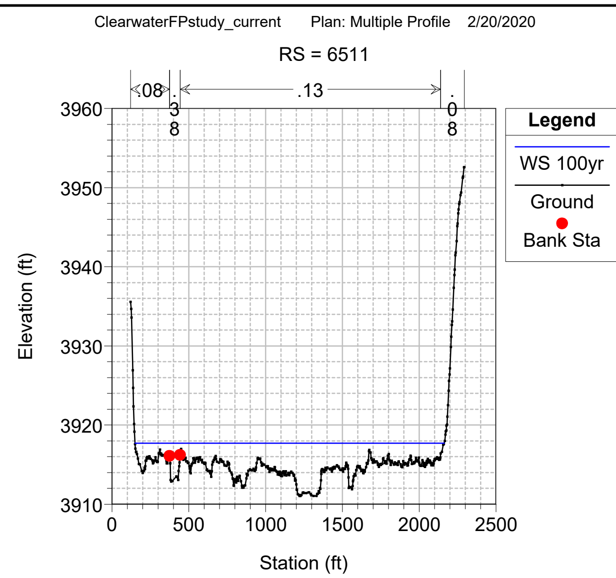

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 11906
.08
.038
.13
.08
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Ineff
Bank Sta

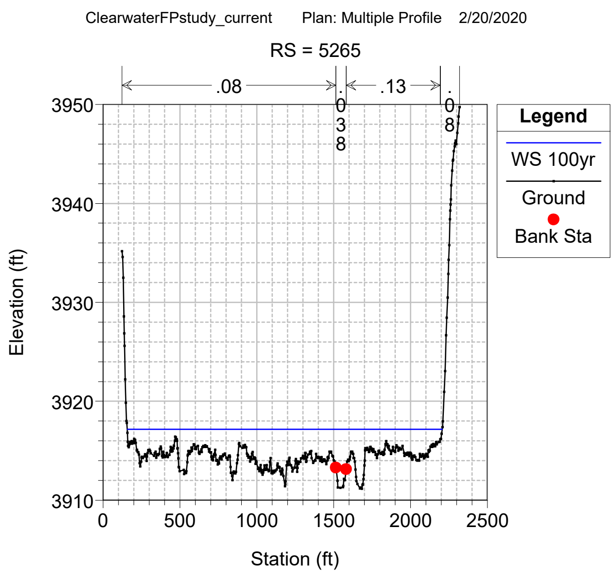

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 11513
.08
.038
.13
.08
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Ineff
Bank Sta

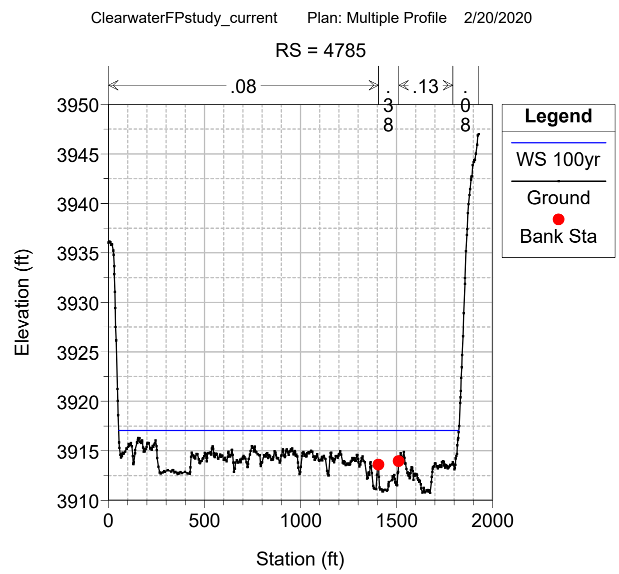

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 10866
.08
.13
.038
.13
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Ineff
Bank Sta

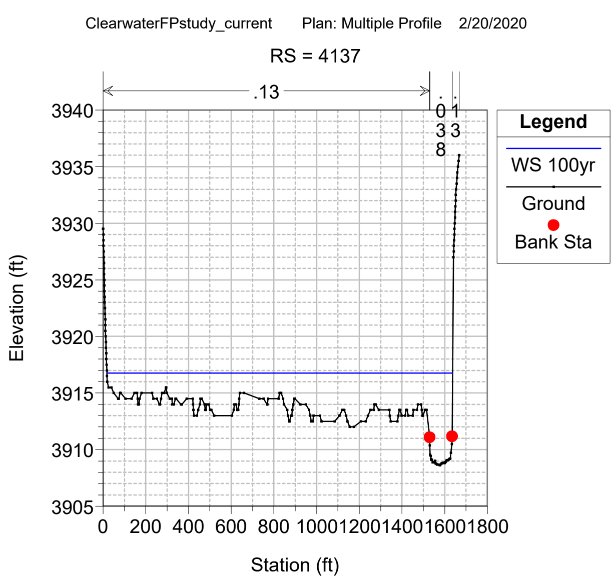

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 10035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 9645
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 8984
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 8688
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 8169
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 7346
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

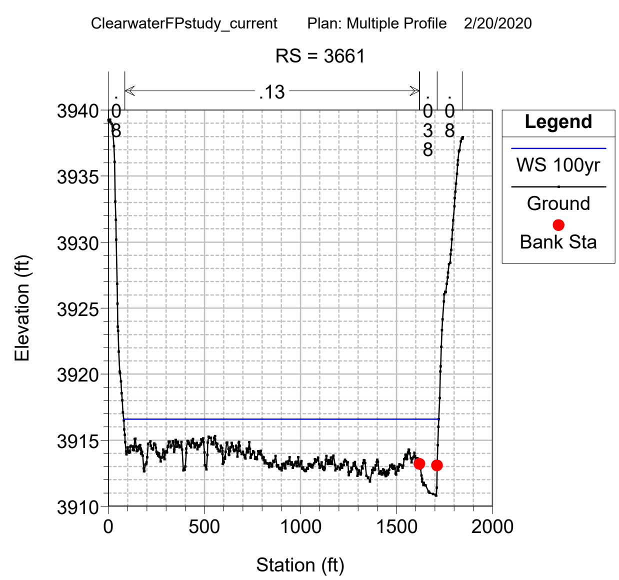

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 7041
.13
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Bank Sta

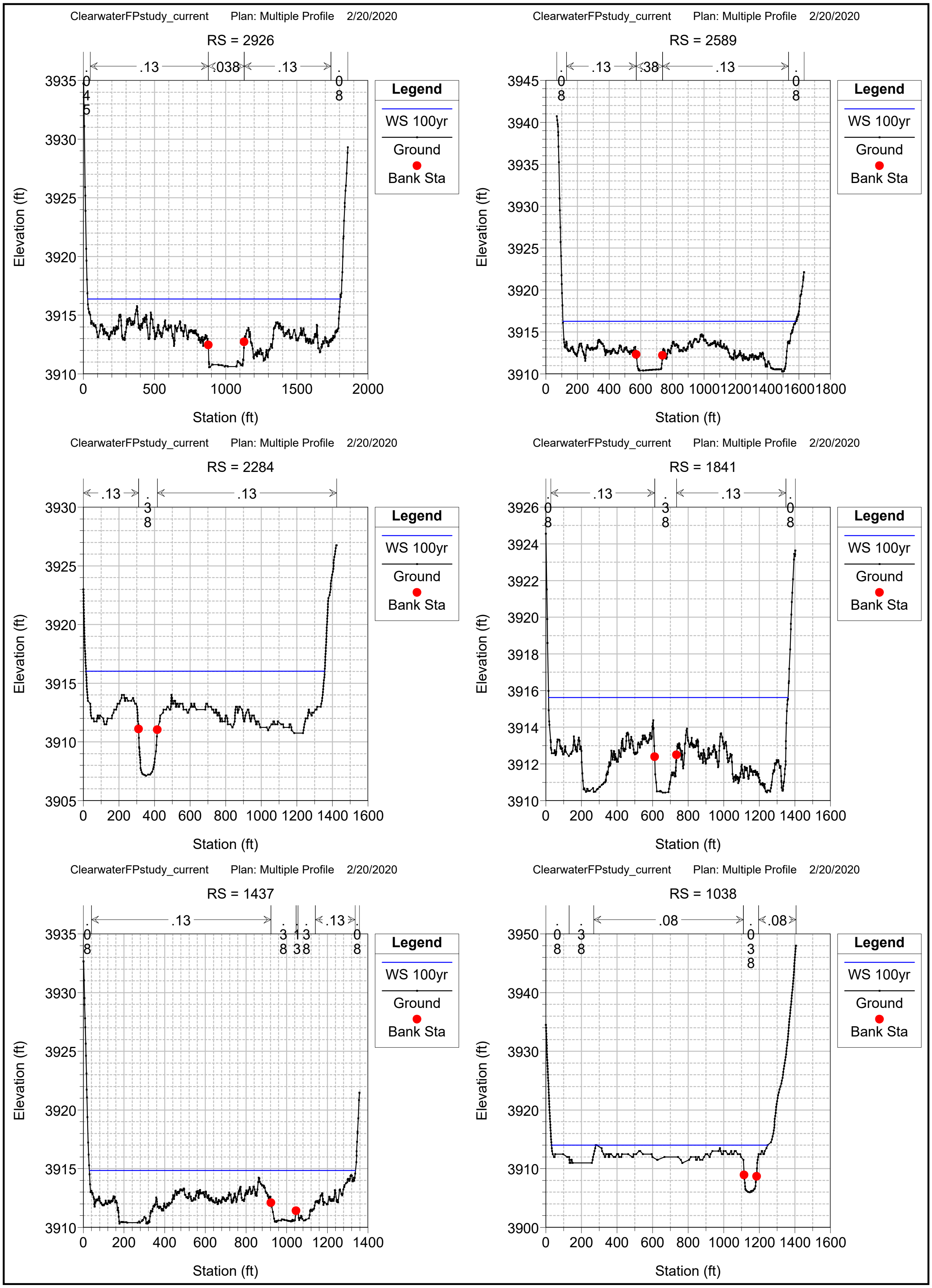

ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 6511
.08
.13
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Bank Sta


ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 5265
.08
.13
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Bank Sta


ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 4785
.08
.13
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Bank Sta


ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 4137
.13
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Bank Sta


ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 3661
.13
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Bank Sta


ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 2926
.13
.038
.13
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Bank Sta
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 2589
.13
.038
.13
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Bank Sta
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 2284
.13
.038
.13
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Bank Sta
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 1841
.13
.038
.13
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Bank Sta
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 1437
.13
.13
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Bank Sta
ClearwaterFPstudy_current Plan: Multiple Profile 2/20/2020
RS = 1038
.08
.08
Elevation (ft)
Station (ft)
Legend
WS 100yr
Ground
Bank Sta

Appendix G
Hydraulic Analysis Tables

Clearwater River - Physical Map Revision
Enhanced Hydraulic Analysis Report

Missoula County

CROSS SECTION DISCHARGE AND ELEVATION TABLE

River	Reach	River Station	Letter	Q Total					Water Surface Elevation				
				10yr	25yr	50yr	100yr	500yr	10yr	25yr	50yr	100yr	500yr
Clearwater	Study	50541	AZ	1630	1940	2200	2460	3010	4000.34	4000.81	4001.18	4001.52	4002.19
Clearwater	Study	50199		1630	1940	2200	2460	3010	4000.34	4000.81	4001.17	4001.52	4002.19
Clearwater	Study	49821	AY	1630	1940	2200	2460	3010	4000.34	4000.80	4001.17	4001.51	4002.18
Clearwater	Study	49314		1630	1940	2200	2460	3010	4000.33	4000.79	4001.16	4001.50	4002.17
Clearwater	Study	48866	AX	1630	1940	2200	2460	3010	4000.32	4000.79	4001.15	4001.49	4002.16
Clearwater	Study	48537		1630	1940	2200	2460	3010	4000.32	4000.78	4001.15	4001.49	4002.15
Clearwater	Study	48116		1630	1940	2200	2460	3010	4000.31	4000.77	4001.14	4001.48	4002.14
Clearwater	Study	47745	AW	1630	1940	2200	2460	3010	4000.31	4000.77	4001.13	4001.47	4002.13
Clearwater	Study	47280		1630	1940	2200	2460	3010	4000.30	4000.76	4001.12	4001.46	4002.13
Clearwater	Study	46726		1630.0	1940	2200	2460	3010	4000.30	4000.76	4001.12	4001.46	4002.12
Clearwater	Study	46256	AV	1630	1940	2200	2460	3010	4000.29	4000.75	4001.11	4001.45	4002.11
Clearwater	Study	45645		1630	1940	2200	2460	3010	4000.29	4000.74	4001.10	4001.44	4002.10
Clearwater	Study	45210		1630	1940	2200	2460	3010	4000.28	4000.74	4001.10	4001.44	4002.10
Clearwater	Study	44843	AU	1630	1940	2200	2460	3010	4000.28	4000.74	4001.10	4001.44	4002.10
Clearwater	Study	44320		1630	1940	2200	2460	3010	4000.28	4000.73	4001.09	4001.43	4002.09
Clearwater	Study	43847		1630	1940	2200	2460	3010	4000.27	4000.73	4001.09	4001.43	4002.09
Clearwater	Study	43340	AT	1630	1940	2200	2460	3010	4000.26	4000.72	4001.08	4001.42	4002.08
Clearwater	Study	42996		1630	1940	2200	2460	3010	4000.26	4000.71	4001.07	4001.41	4002.07
Clearwater	Study	42597		1630	1940	2200	2460	3010	4000.23	4000.69	4001.05	4001.39	4002.06
Clearwater	Study	42191	AS	1630	1940	2200	2460	3010	4000.21	4000.67	4001.03	4001.37	4002.04
Clearwater	Study	41623		1630	1940	2200	2460	3010	4000.17	4000.63	4000.99	4001.33	4001.99
Clearwater	Study	41143	AR	1630	1940	2200	2460	3010	4000.07	4000.51	4000.86	4001.19	4001.83
Clearwater	Study	40830		1630	1940	2200	2460	3010	3999.74	4000.18	4000.53	4000.86	4001.49
Clearwater	Study	40798		1630	1940	2200	2460	3010	3999.70	4000.11	4000.44	4000.75	4001.34
Clearwater	Study	40757		Bridge									

CROSS SECTION DISCHARGE AND ELEVATION TABLE

River	Reach	River Station	Letter	Q Total					Water Surface Elevation				
				10yr	25yr	50yr	100yr	500yr	10yr	25yr	50yr	100yr	500yr
Clearwater	Study	40727		1630	1940	2200	2460	3010	3998.90	3999.25	3999.51	3999.75	4000.14
Clearwater	Study	40682		1630	1940	2200	2460	3010	3998.87	3999.23	3999.50	3999.75	4000.16
Clearwater	Study	40283	AQ	1630	1940	2200	2460	3010	3998.29	3998.64	3998.90	3999.14	3999.49
Clearwater	Study	39992		1630	1940	2200	2460	3010	3997.70	3998.03	3998.27	3998.51	3998.99
Clearwater	Study	39726	AP	1630	1940	2200	2460	3010	3997.32	3997.65	3997.90	3998.13	3998.59
Clearwater	Study	39104		1630	1940	2200	2460	3010	3994.41	3994.69	3994.93	3995.16	3995.63
Clearwater	Study	38646	AO	1630	1940	2200	2460	3010	3993.20	3993.57	3993.86	3994.14	3994.69
Clearwater	Study	38416		1630	1940	2200	2460	3010	3992.77	3993.13	3993.41	3993.69	3994.23
Clearwater	Study	38197	AN	1630	1940	2200	2460	3010	3991.96	3992.30	3992.58	3992.84	3993.36
Clearwater	Study	37905		1630	1940	2200	2460	3010	3990.94	3991.33	3991.63	3991.91	3992.46
Clearwater	Study	37419	AM	1630	1940	2200	2460	3010	3989.40	3989.78	3990.08	3990.37	3990.92
Clearwater	Study	36952		1630	1940	2200	2460	3010	3988.13	3988.51	3988.80	3989.09	3989.64
Clearwater	Study	36572	AL	1630	1940	2200	2460	3010	3987.52	3987.89	3988.18	3988.46	3989.01
Clearwater	Study	36154		1630	1940	2200	2460	3010	3986.02	3986.42	3986.73	3987.02	3987.57
Clearwater	Study	35568	AK	1630	1940	2200	2460	3010	3984.98	3985.31	3985.57	3985.82	3986.24
Clearwater	Study	35301		1630	1940	2200	2460	3010	3984.43	3984.73	3984.97	3985.21	3985.56
Clearwater	Study	34866	AJ	1630	1940	2200	2460	3010	3981.89	3982.28	3982.59	3982.88	3983.47
Clearwater	Study	34391		1630	1940	2200	2460	3010	3980.60	3980.98	3981.28	3981.56	3982.11
Clearwater	Study	34271	AI	1630	1940	2200	2460	3010	3980.37	3980.75	3981.05	3981.33	3981.87
Clearwater	Study	34228		1630	1940	2200	2460	3010	3980.05	3980.40	3980.67	3980.92	3981.42
Clearwater	Study	34187		1630	1940	2200	2460	3010	3980.07	3980.41	3980.68	3980.94	3981.44
Clearwater	Study	34165		Bridge									
Clearwater	Study	34142		1630	1940	2200	2460	3010	3979.93	3980.24	3980.47	3980.68	3981.07
Clearwater	Study	34123		1630	1940	2200	2460	3010	3979.61	3979.93	3980.17	3980.41	3980.86
Clearwater	Study	34011	AH	1630	1940	2200	2460	3010	3979.03	3979.32	3979.54	3979.76	3980.17

CROSS SECTION DISCHARGE AND ELEVATION TABLE

River	Reach	River Station	Letter	Q Total					Water Surface Elevation				
				10yr	25yr	50yr	100yr	500yr	10yr	25yr	50yr	100yr	500yr
Clearwater	Study	33828		1630	1940	2200	2460	3010	3978.28	3978.56	3978.77	3978.97	3979.36
Clearwater	Study	33438		1630	1940	2200	2460	3010	3976.55	3976.86	3977.11	3977.36	3977.88
Clearwater	Study	33007	AG	1630	1940	2200	2460	3010	3975.09	3975.52	3975.86	3976.19	3976.85
Clearwater	Study	32617		1630	1940	2200	2460	3010	3974.16	3974.58	3974.91	3975.24	3975.87
Clearwater	Study	32315	AF	1630	1940	2200	2460	3010	3973.32	3973.78	3974.14	3974.48	3975.18
Clearwater	Study	32190		1630	1940	2200	2460	3010	3973.09	3973.58	3973.96	3974.32	3975.04
Clearwater	Study	32131		1630	1940	2200	2460	3010	3972.95	3973.39	3973.73	3974.05	3974.70
Clearwater	Study	32091		Bridge									
Clearwater	Study	32053		1630	1940	2200	2460	3010	3972.43	3972.76	3973.01	3973.24	3973.68
Clearwater	Study	32023		1630	1940	2200	2460	3010	3971.91	3972.25	3972.51	3972.72	3973.17
Clearwater	Study	31987	AE	1630	1940	2200	2460	3010	3972.03	3972.37	3972.63	3972.86	3973.32
Clearwater	Study	31592		1630	1940	2200	2460	3010	3971.25	3971.59	3971.84	3972.01	3972.45
Clearwater	Study	31205	AD	1630	1940	2200	2460	3010	3970.39	3970.74	3970.99	3971.03	3971.41
Clearwater	Study	30634		1630	1940	2200	2460	3010	3967.43	3967.72	3967.94	3968.41	3968.63
Clearwater	Study	29596	AC	1630	1940	2200	2460	3010	3965.86	3966.15	3966.37	3966.56	3966.95
Clearwater	Study	28895		1630	1940	2200	2460	3010	3964.51	3964.76	3964.94	3965.11	3965.44
Clearwater	Study	28408	AB	1630	1940	2200	2460	3010	3962.73	3962.99	3963.16	3963.29	3963.59
Clearwater	Study	27958		1630	1940	2200	2460	3010	3961.21	3961.39	3961.54	3961.65	3961.83
Clearwater	Study	27507	AA	1630	1940	2200	2460	3010	3959.89	3960.08	3960.24	3960.38	3960.65
Clearwater	Study	27055		1630	1940	2200	2460	3010	3958.53	3958.76	3958.95	3959.12	3959.47
Clearwater	Study	26424	Z	1630	1940	2200	2460	3010	3957.41	3957.71	3957.94	3958.16	3958.60
Clearwater	Study	25799		1630	1940	2200	2460	3010	3956.22	3956.62	3956.93	3957.21	3957.78
Clearwater	Study	25140	Y	1630	1940	2200	2460	3010	3955.55	3956.01	3956.36	3956.69	3957.31
Clearwater	Study	24843		1630	1940	2200	2460	3010	3955.34	3955.79	3956.13	3956.45	3957.06
Clearwater	Study	24443	X	1630	1940	2200	2460	3010	3954.65	3955.10	3955.44	3955.77	3956.39

CROSS SECTION DISCHARGE AND ELEVATION TABLE

River	Reach	River Station	Letter	Q Total					Water Surface Elevation				
				10yr	25yr	50yr	100yr	500yr	10yr	25yr	50yr	100yr	500yr
Clearwater	Study	24108		1630	1940	2200	2460	3010	3953.62	3954.06	3954.36	3954.67	3955.25
Clearwater	Study	23834	W	1630	1940	2200	2460	3010	3953.33	3953.75	3954.04	3954.32	3954.87
Clearwater	Study	23245	V	1630	1940	2200	2460	3010	3950.78	3951.06	3951.37	3951.58	3951.99
Clearwater	Study	22937		1630	1940	2200	2460	3010	3949.71	3950.08	3950.33	3950.58	3951.05
Clearwater	Study	22670	U	1630	1940	2200	2460	3010	3949.16	3949.48	3949.67	3949.86	3950.20
Clearwater	Study	22372		1630	1940	2200	2460	3010	3948.71	3949.00	3949.18	3949.36	3949.74
Clearwater	Study	22266	T	1840	2280	2620	2990	3890	3948.06	3948.32	3948.46	3948.62	3948.91
Clearwater	Study	22080		1840	2280	2620	2990	3890	3946.44	3946.77	3947.02	3947.26	3947.69
Clearwater	Study	21765	S	1840	2280	2620	2990	3890	3945.98	3946.39	3946.68	3946.93	3947.53
Clearwater	Study	21456		1840	2280	2620	2990	3890	3945.65	3946.10	3946.40	3946.68	3947.32
Clearwater	Study	20606	R	1840	2280	2620	2990	3890	3944.68	3945.13	3945.43	3945.74	3946.40
Clearwater	Study	20349		1840	2280	2620	2990	3890	3944.43	3944.87	3945.16	3945.45	3946.08
Clearwater	Study	20039	Q	1840	2280	2620	2990	3890	3943.74	3944.17	3944.46	3944.75	3945.38
Clearwater	Study	19882		1840	2280	2620	2990	3890	3943.12	3943.49	3943.74	3943.98	3944.52
Clearwater	Study	19491	P	1840	2280	2620	2990	3890	3941.85	3942.20	3942.43	3942.66	3943.18
Clearwater	Study	19099		1840	2280	2620	2990	3890	3940.45	3940.86	3941.13	3941.40	3941.96
Clearwater	Study	18678		1840	2280	2620	2990	3890	3939.79	3940.23	3940.52	3940.82	3941.40
Clearwater	Study	18326	O	1840	2280	2620	2990	3890	3938.68	3939.06	3939.30	3939.54	3940.06
Clearwater	Study	17876		1840	2280	2620	2990	3890	3937.39	3937.73	3937.96	3938.19	3938.70
Clearwater	Study	17491	N	1840	2280	2620	2990	3890	3936.74	3937.09	3937.34	3937.59	3938.12
Clearwater	Study	16900		1840	2280	2620	2990	3890	3935.43	3935.84	3936.12	3936.40	3937.02
Clearwater	Study	16619	M	1840	2280	2620	2990	3890	3934.81	3935.27	3935.58	3935.90	3936.57
Clearwater	Study	16158		1840	2280	2620	2990	3890	3933.91	3934.39	3934.72	3935.06	3935.81
Clearwater	Study	15663	L	1840	2280	2620	2990	3890	3933.18	3933.69	3934.05	3934.41	3935.19
Clearwater	Study	15238		1840	2280	2620	2990	3890	3932.60	3933.15	3933.52	3933.89	3934.68

CROSS SECTION DISCHARGE AND ELEVATION TABLE

River	Reach	River Station	Letter	Q Total					Water Surface Elevation				
				10yr	25yr	50yr	100yr	500yr	10yr	25yr	50yr	100yr	500yr
Clearwater	Study	14989	K	1840	2280	2620	2990	3890	3931.22	3931.65	3931.96	3932.22	3932.82
Clearwater	Study	14705		1840	2280	2620	2990	3890	3930.66	3931.08	3931.36	3931.64	3932.27
Clearwater	Study	14435	J	1840	2280	2620	2990	3890	3930.24	3930.66	3930.94	3931.22	3931.87
Clearwater	Study	14069	I	1840	2280	2620	2990	3890	3929.03	3929.48	3929.85	3930.26	3931.29
Clearwater	Study	13798		1840	2280	2620	2990	3890	3928.95	3929.44	3929.82	3930.24	3931.26
Clearwater	Study	13634	H	1840	2280	2620	2990	3890	3928.72	3929.28	3929.69	3930.13	3931.18
Clearwater	Study	12907		1840	2280	2620	2990	3890	3928.32	3928.93	3929.37	3929.84	3930.93
Clearwater	Study	12607	G	1840	2280	2620	2990	3890	3928.09	3928.70	3929.14	3929.61	3930.70
Clearwater	Study	12225		1840	2280	2620	2990	3890	3927.27	3927.88	3928.32	3928.79	3929.90
Clearwater	Study	12187		1840	2280	2620	2990	3890	3927.06	3927.59	3927.98	3928.40	3929.40
Clearwater	Study	12144		Bridge									
Clearwater	Study	12096		1840	2280	2620	2990	3890	3926.57	3926.94	3927.19	3927.45	3928.01
Clearwater	Study	12040		1840	2280	2620	2990	3890	3926.35	3926.75	3927.02	3927.29	3927.86
Clearwater	Study	11906	F	1840	2280	2620	2990	3890	3926.27	3926.68	3926.98	3927.26	3927.90
Clearwater	Study	11513		1840	2280	2620	2990	3890	3925.82	3926.20	3926.47	3926.72	3927.29
Clearwater	Study	10866		2440	2990	3440	3900	5040	3924.25	3924.45	3924.61	3924.77	3925.11
Clearwater	Study	10035	E	2440	2990	3440	3900	5040	3922.02	3922.29	3922.47	3922.64	3923.03
Clearwater	Study	9645		2440	2990	3440	3900	5040	3921.24	3921.49	3921.66	3921.83	3922.20
Clearwater	Study	8984		2440	2990	3440	3900	5040	3920.07	3920.30	3920.47	3920.63	3920.99
Clearwater	Study	8688	D	2440	2990	3440	3900	5040	3919.43	3919.69	3919.85	3920.01	3920.38
Clearwater	Study	8169		2440	2990	3440	3900	5040	3918.09	3918.40	3918.64	3918.86	3919.38
Clearwater	Study	7346	C	2440	2990	3440	3900	5040	3917.25	3917.59	3917.85	3918.09	3918.66
Clearwater	Study	7041		2440	2990	3440	3900	5040	3917.13	3917.47	3917.72	3917.97	3918.53
Clearwater	Study	6511		2440	2990	3440	3900	5040	3916.88	3917.22	3917.46	3917.71	3918.27
Clearwater	Study	5265		2440	2990	3440	3900	5040	3916.28	3916.64	3916.91	3917.17	3917.76

CROSS SECTION DISCHARGE AND ELEVATION TABLE

River	Reach	River Station	Letter	Q Total					Water Surface Elevation				
				10yr	25yr	50yr	100yr	500yr	10yr	25yr	50yr	100yr	500yr
Clearwater	Study	4785		2440	2990	3440	3900	5040	3916.11	3916.49	3916.77	3917.03	3917.63
Clearwater	Study	4137	B	2440	2990	3440	3900	5040	3915.86	3916.23	3916.50	3916.76	3917.35
Clearwater	Study	3661		2440	2990	3440	3900	5040	3915.69	3916.06	3916.33	3916.59	3917.17
Clearwater	Study	2926		2440	2990	3440	3900	5040	3915.50	3915.86	3916.12	3916.38	3916.95
Clearwater	Study	2589		2440	2990	3440	3900	5040	3915.41	3915.76	3916.03	3916.28	3916.84
Clearwater	Study	2284		2440	2990	3440	3900	5040	3915.19	3915.53	3915.79	3916.03	3916.58
Clearwater	Study	1841		2440	2990	3440	3900	5040	3914.82	3915.15	3915.39	3915.62	3916.15
Clearwater	Study	1437		2440	2990	3440	3900	5040	3914.01	3914.35	3914.61	3914.85	3915.36
Clearwater	Study	1038	A	2440	2990	3440	3900	5040	3913.12	3913.50	3913.77	3914.03	3914.57

SUMMARY OF MODELED HYRAULIC STRUCTURES

Flooding Source	Location	River Station	Type	Approx. Total Bridge Span (ft)	Number of Piers	Pier / Drag Coeff	Pressure / Weir or Energy Flow	Culvert Length (ft)	Culvert Type	Culvert Shape
Clearwater River	Riverview Drive	40757	Bridge	100	6	2.00	Energy/ Momentum			
Clearwater River	West Wagon Wheel Court	34615	Bridge	83			Energy			
Clearwater River	Wagon Wheel Way	32091	Bridge	78	4	1.20	Energy/ Momentum			
Clearwater River	Placid Creek Road	12144	Bridge	58			Energy			

EXPLANATION OF INEFFECTIVE AND BLOCKED FLOWS				
Flooding Source	Reach	Cross Section	Letter	Reason for Ineffective/Blocked Area
Clearwater River	Study	49821	AY	Right side ineffective - hydraulically disconnected
Clearwater River	Study	49314		Left side ineffective - hydraulically disconnected
Clearwater River	Study	48866	AX	Left side ineffective - hydraulically disconnected
Clearwater River	Study	48537		Left side ineffective - hydraulically disconnected
Clearwater River	Study	48116		Left side ineffective - hydraulically disconnected
Clearwater River	Study	47745	AW	Left side ineffective - hydraulically disconnected
Clearwater River	Study	47280		Left side ineffective - hydraulically disconnected
Clearwater River	Study	46726		Left side ineffective - hydraulically disconnected
Clearwater River	Study	46256	AV	Right and left side ineffective - hydraulically disconnected
Clearwater River	Study	45645		Right and left side ineffective - hydraulically disconnected
Clearwater River	Study	45210		Left side ineffective - hydraulically disconnected
Clearwater River	Study	44843	AU	Left side ineffective - hydraulically disconnected
Clearwater River	Study	44320		Left side ineffective - hydraulically disconnected
Clearwater River	Study	43847		Right and left side ineffective - hydraulically disconnected
Clearwater River	Study	43340	AT	Left side ineffective - hydraulically disconnected
Clearwater River	Study	42996		Left side ineffective - hydraulically disconnected
Clearwater River	Study	42597		Right and left side ineffective - hydraulically disconnected
Clearwater River	Study	42191	AS	Left side ineffective - hydraulically disconnected
Clearwater River	Study	41623		Left side ineffective - hydraulically disconnected
Clearwater River	Study	40830		Ineffective areas related to structure
Clearwater River	Study	40798		Ineffective areas related to structure
Clearwater River	Study	40727		Ineffective areas related to structure
Clearwater River	Study	40682		Ineffective areas related to structure
Clearwater River	Study	39992		Right side ineffective - hydraulically disconnected
Clearwater River	Study	36952		Left side ineffective - hydraulically disconnected
Clearwater River	Study	34187		Ineffective areas related to structure
Clearwater River	Study	34142		Ineffective areas related to structure
Clearwater River	Study	34011	AH	Right side ineffective - hydraulically disconnected
Clearwater River	Study	33438		Left side ineffective - hydraulically disconnected
Clearwater River	Study	32190		Ineffective areas related to structure
Clearwater River	Study	32131		Ineffective areas related to structure

EXPLANATION OF INEFFECTIVE AND BLOCKED FLOWS				
Flooding Source	Reach	Cross Section	Letter	Reason for Ineffective/Blocked Area
Clearwater River	Study	32053		Ineffective areas related to structure
Clearwater River	Study	32023		Ineffective areas related to structure
Clearwater River	Study	31987	AE	Ineffective areas related to structure
Clearwater River	Study	29596	AC	Right side ineffective - hydraulically disconnected
Clearwater River	Study	28895		Left side ineffective - hydraulically disconnected
Clearwater River	Study	24843		Left side ineffective - hydraulically disconnected
Clearwater River	Study	24108		Left side ineffective - hydraulically disconnected
Clearwater River	Study	22372		Left side ineffective - hydraulically disconnected
Clearwater River	Study	22266	T	Left side ineffective - hydraulically disconnected
Clearwater River	Study	22080		Left side ineffective - hydraulically disconnected
Clearwater River	Study	21765	S	Left side ineffective - isolated from main channel by highway
Clearwater River	Study	21456		Left side ineffective - isolated from main channel by highway
Clearwater River	Study	20606	R	Left side ineffective - hydraulically disconnected
Clearwater River	Study	20349		Left side ineffective - hydraulically disconnected
Clearwater River	Study	20039	Q	Left side ineffective - hydraulically disconnected
Clearwater River	Study	19882		Left side ineffective - hydraulically disconnected
Clearwater River	Study	19491	P	Left side ineffective - isolated from main channel by highway
Clearwater River	Study	19099		Left side ineffective - isolated from main channel by highway
Clearwater River	Study	18678		Left side ineffective - isolated from main channel by highway
Clearwater River	Study	18326	O	Left side ineffective - isolated from main channel by highway
Clearwater River	Study	17876		Left side ineffective - isolated from main channel by highway
Clearwater River	Study	17491	N	Left side ineffective - isolated from main channel by highway
Clearwater River	Study	16900		Left side ineffective - isolated from main channel by highway
Clearwater River	Study	16619	M	Left side ineffective - isolated from main channel by highway
Clearwater River	Study	14989	K	Left side ineffective - hydraulically disconnected
Clearwater River	Study	14435	J	Left side ineffective - isolated from main channel by highway
Clearwater River	Study	14069	I	Right and left side ineffective - hydraulically disconnected
Clearwater River	Study	13798		Left side ineffective - hydraulically disconnected
Clearwater River	Study	13634	H	Left side ineffective - hydraulically disconnected
Clearwater River	Study	12907		Right and left side ineffective - hydraulically disconnected
Clearwater River	Study	12607	G	Right and left side ineffective - hydraulically disconnected

EXPLANATION OF INEFFECTIVE AND BLOCKED FLOWS				
Flooding Source	Reach	Cross Section	Letter	Reason for Ineffective/Blocked Area
Clearwater River	Study	12225		Ineffective areas related to structure
Clearwater River	Study	12187		Ineffective areas related to structure
Clearwater River	Study	12096		Ineffective areas related to structure
Clearwater River	Study	12040		Ineffective areas related to structure
Clearwater River	Study	11906	F	Ineffective areas related to structure
Clearwater River	Study	11513		Right and left side ineffective - hydraulically disconnected
Clearwater River	Study	10866		Left side ineffective - hydraulically disconnected
Clearwater River	Study	10035	E	Left side ineffective - hydraulically disconnected

Appendix H
FIS Text

5.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Base flood elevations on the FIRM represent the elevations shown on the Flood Profiles and in the Floodway Data tables in the FIS Report. Rounded whole-foot elevations may be shown on the FIRM in coastal areas, areas of ponding, and other areas with static base flood elevations. These whole-foot elevations may not exactly reflect the elevations derived from the hydraulic analyses. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS Report in conjunction with the data shown on the FIRM. **The hydraulic analyses for this FIS were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.**

For streams for which hydraulic analyses were based on cross sections, locations of selected cross sections are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 6.3), selected cross sections are also listed in Error! Reference source not found., "Floodway Data."

A summary of the methods used in hydraulic analyses performed for this project is provided in Table 1. Roughness coefficients are provided in Table 2. Roughness coefficients are values representing the frictional resistance water experiences when passing overland or through a channel. They are used in the calculations to determine water surface elevations. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

Table 1: Summary of Hydrologic and Hydraulic Analyses

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Clearwater River	**Confluence with Salmon Lake near Seeley Lake, MT**	**4,600 ft upstream of Riverview Dr.**	**Regional regression analysis, Basin area-weighted gage transfer**	**HEC-RAS 5.0.7**	**12/16/2019**	**AE**	**Floodway analyses performed through study reach**

Table 2: Roughness Coefficients

Flooding Source	Channel "n"	Overbank "n"
Clearwater River	**0.038**	**0.04-0.13**

Appendix I
Floodway Data Tables

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Clearwater River								
A	1,038	637	1,920	2.0	3,914.0	3,914.0	3,914.5	0.5
B	4,137	1,056	4,407	0.9	3,916.8	3,916.8	3,917.2	0.4
C	7,346	1,424	4,533	0.9	3,918.1	3,918.1	3,918.5	0.4
D	8,688	1,736	4,187	0.9	3,920.0	3,920.0	3,920.5	0.5
E	10,035	1,368	3,088	1.3	3,922.6	3,922.6	3,923.1	0.5
F	11,906	326	1,446	2.1	3,927.3	3,927.3	3,927.7	0.4
G	12,607	276	1,374	2.2	3,929.6	3,929.6	3,929.9	0.3
H	13,634	1,004	3,165	0.9	3,930.1	3,930.1	3,930.5	0.3
I	14,069	426	1,070	2.8	3,930.3	3,930.3	3,930.6	0.3
J	14,435	545	1,283	2.3	3,931.2	3,931.2	3,931.7	0.5
K	14,989	153	520	5.8	3,932.2	3,932.2	3,932.6	0.4
L	15,663	257	981	3.1	3,934.4	3,934.4	3,934.7	0.3
M	16,619	215	856	3.5	3,935.9	3,935.9	3,936.3	0.4
N	17,491	635	1,976	1.5	3,937.6	3,937.6	3,938.1	0.5
O	18,326	244	689	4.3	3,939.5	3,939.5	3,939.9	0.4
P	19,491	446	1,295	2.3	3,942.7	3,942.7	3,943.1	0.4
Q	20,039	380	1,390	2.2	3,944.8	3,944.8	3,945.1	0.3
R	20,606	126	649	4.6	3,945.7	3,945.7	3,946.1	0.4
S	21,765	448	1,276	2.3	3,946.9	3,946.9	3,947.4	0.4
T	22,266	267	572	5.2	3,948.6	3,948.6	3,949.1	0.4
U	22,670	80	421	5.8	3,949.9	3,949.9	3,950.3	0.4
V	23,245	78	267	9.2	3,951.6	3,951.6	3,951.9	0.3
W	23,834	107	627	3.9	3,954.3	3,954.3	3,954.8	0.4
X	24,443	223	1,087	2.3	3,955.8	3,955.8	3,956.2	0.4
Y	25,140	449	1,559	1.6	3,956.7	3,956.7	3,957.2	0.5
Z	26,424	434	1,092	2.3	3,958.2	3,958.2	3,958.6	0.4

[1] Feet above confluence with Salmon Lake

TABLE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY
MISSOULA COUNTY, MT
AND INCORPORAED AREAS

FLOODWAY DATA

CLEARWATER RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Clearwater River								
AA	27,507	654	891	2.8	3,960.4	3,960.4	3,960.8	0.4
AB	28,408	229	535	4.6	3,963.3	3,963.3	3,963.7	0.4
AC	29,596	216	923	2.7	3,966.6	3,966.6	3,967.0	0.4
AD	31,205	274	1,001	2.5	3,971.0	3,971.0	3,971.4	0.4
AE	31,987	124	526	4.7	3,972.9	3,972.9	3,973.1	0.2
AF	32,315	88	426	5.8	3,974.5	3,974.5	3,974.5	0.0
AG	33,007	98	451	5.5	3,976.2	3,976.2	3,976.3	0.1
AH	34,011	99	386	6.4	3,979.8	3,979.8	3,980.2	0.4
AI	34,271	114	547	4.5	3,981.3	3,981.3	3,981.7	0.4
AJ	34,866	94	317	7.8	3,982.9	3,982.9	3,982.9	0.0
AK	35,568	101	579	4.3	3,985.8	3,985.8	3,986.2	0.4
AL	36,572	118	591	4.2	3,988.5	3,988.5	3,988.8	0.3
AM	37,419	102	435	5.7	3,990.4	3,990.4	3,990.5	0.1
AN	38,197	118	423	5.8	3,992.8	3,992.8	3,992.9	0.1
AO	38,646	196	645	3.8	3,994.1	3,994.1	3,994.1	0.0
AP	39,726	114	529	4.7	3,998.1	3,998.1	3,998.3	0.2
AQ	40,283	126	639	3.9	3,999.1	3,999.1	3,999.5	0.4
AR	41,143	181	1,155	2.1	4,001.2	4,001.2	4,001.6	0.4
AS	42,191	427	2,933	0.8	4,001.4	4,001.4	4,001.7	0.3
AT	43,340	474	3,602	0.7	4,001.4	4,001.4	4,001.8	0.4
AU	44,843	811	5,628	0.4	4,001.4	4,001.4	4,001.8	0.4
AV	46,256	395	3,679	0.7	4,001.5	4,001.5	4,001.8	0.4
AW	47,745	282	2,826	0.9	4,001.5	4,001.5	4,001.8	0.3
AX	48,866	367	3,548	0.7	4,001.5	4,001.5	4,001.9	0.4
AY	49,821	441	3,767	0.7	4,001.5	4,001.5	4,001.9	0.4
AZ	50,541	559	4,139	0.6	4,001.5	4,001.5	4,001.9	0.4

[1] Feet above confluence with Salmon Lake

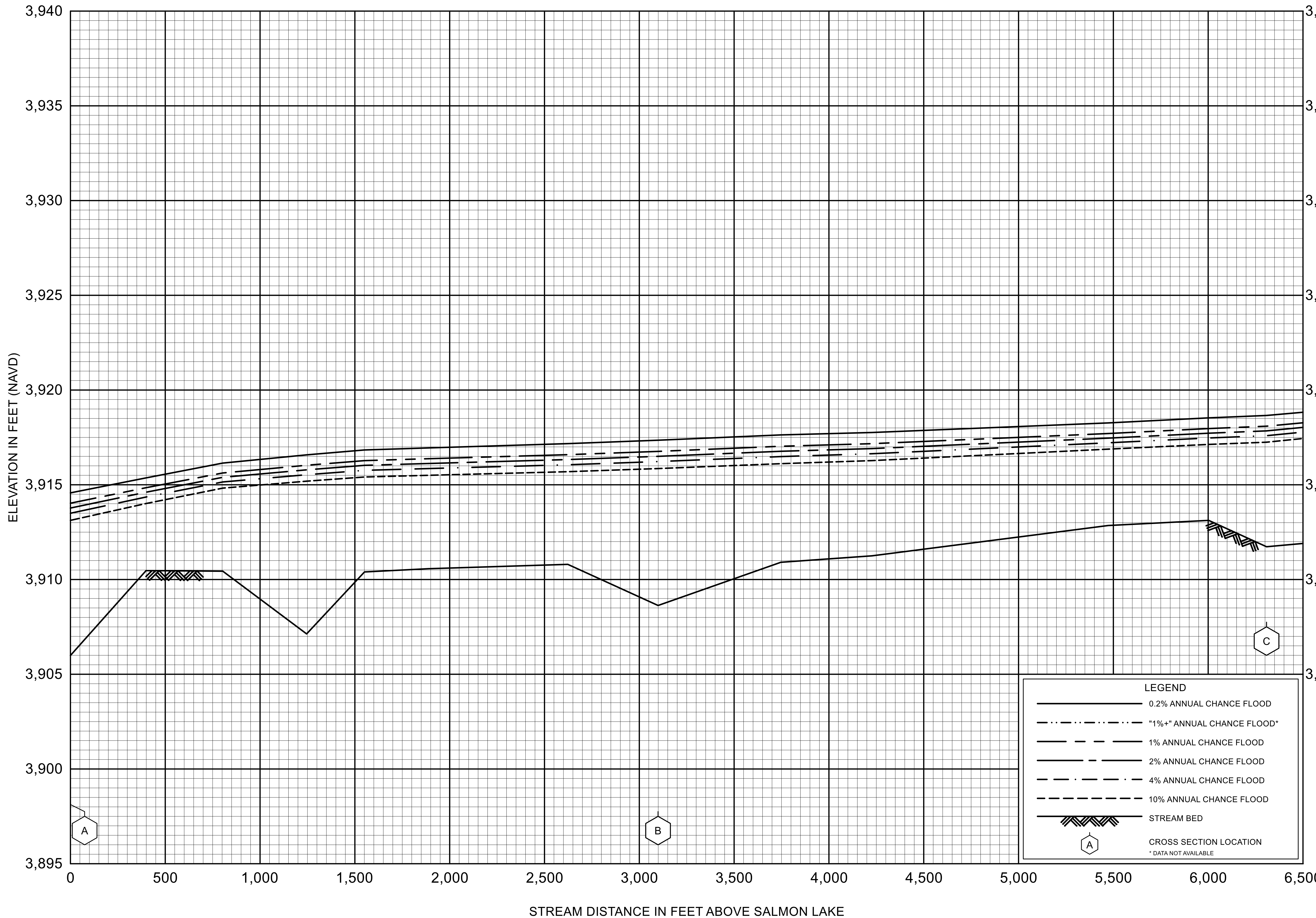
TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
MISSOULA COUNTY, MT
AND INCORPORAED AREAS

FLOODWAY DATA

CLEARWATER RIVER

Appendix J
Profiles



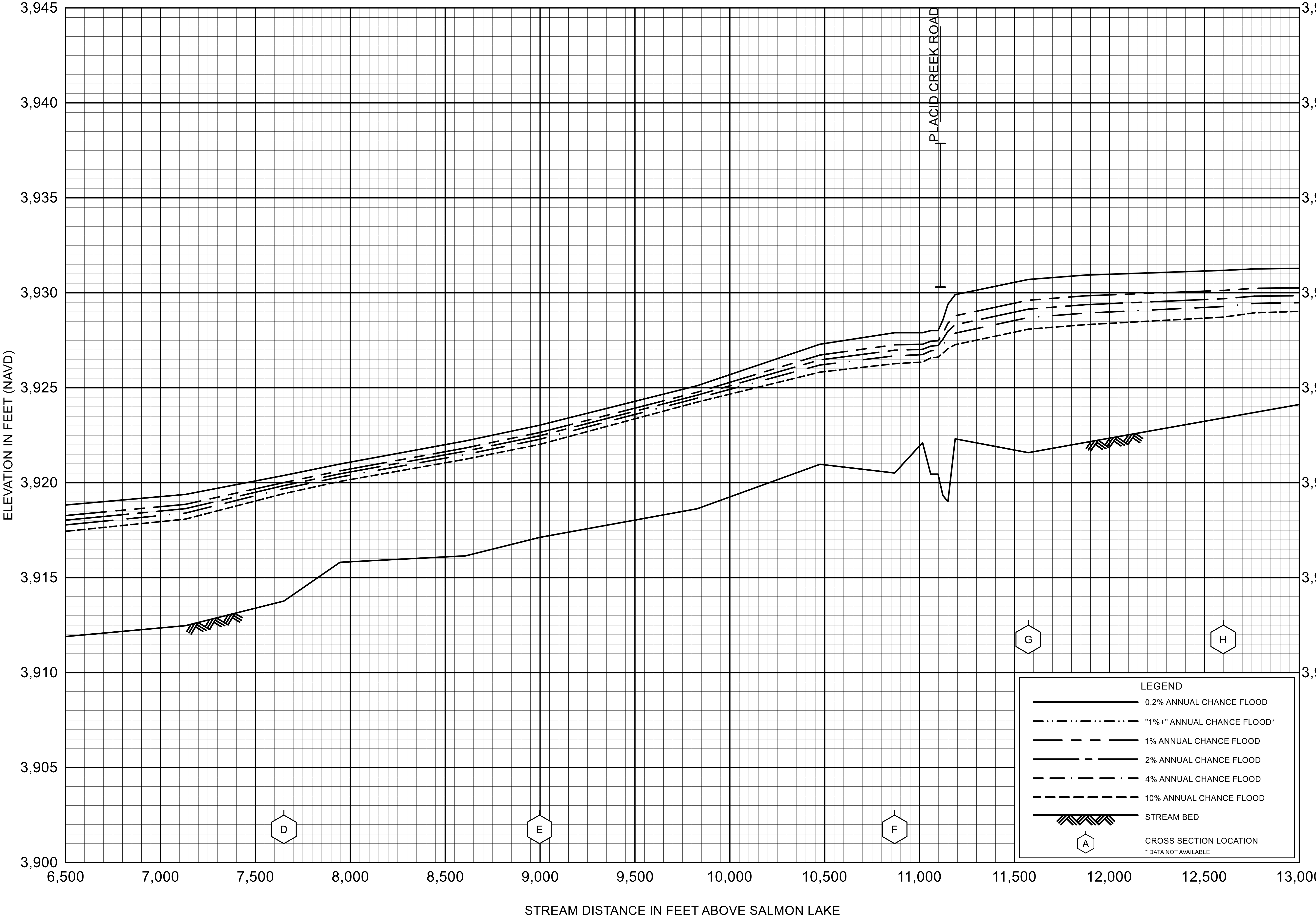
FLOOD PROFILES

CLEARWATER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA, MT

AND INCORPORATED AREAS



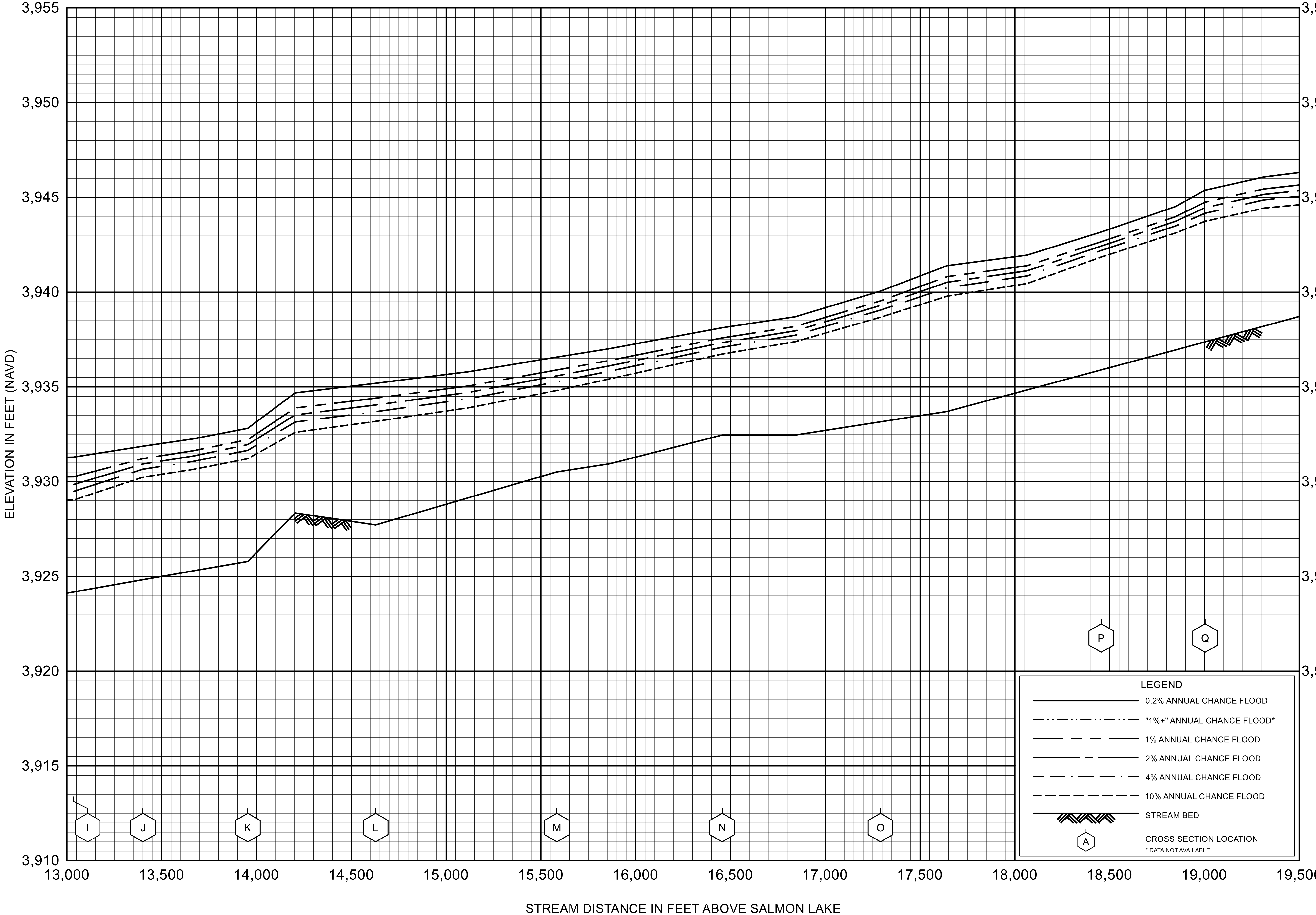
FLOOD PROFILES

CLEARWATER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA, MT

AND INCORPORATED AREAS



FLOOD PROFILES

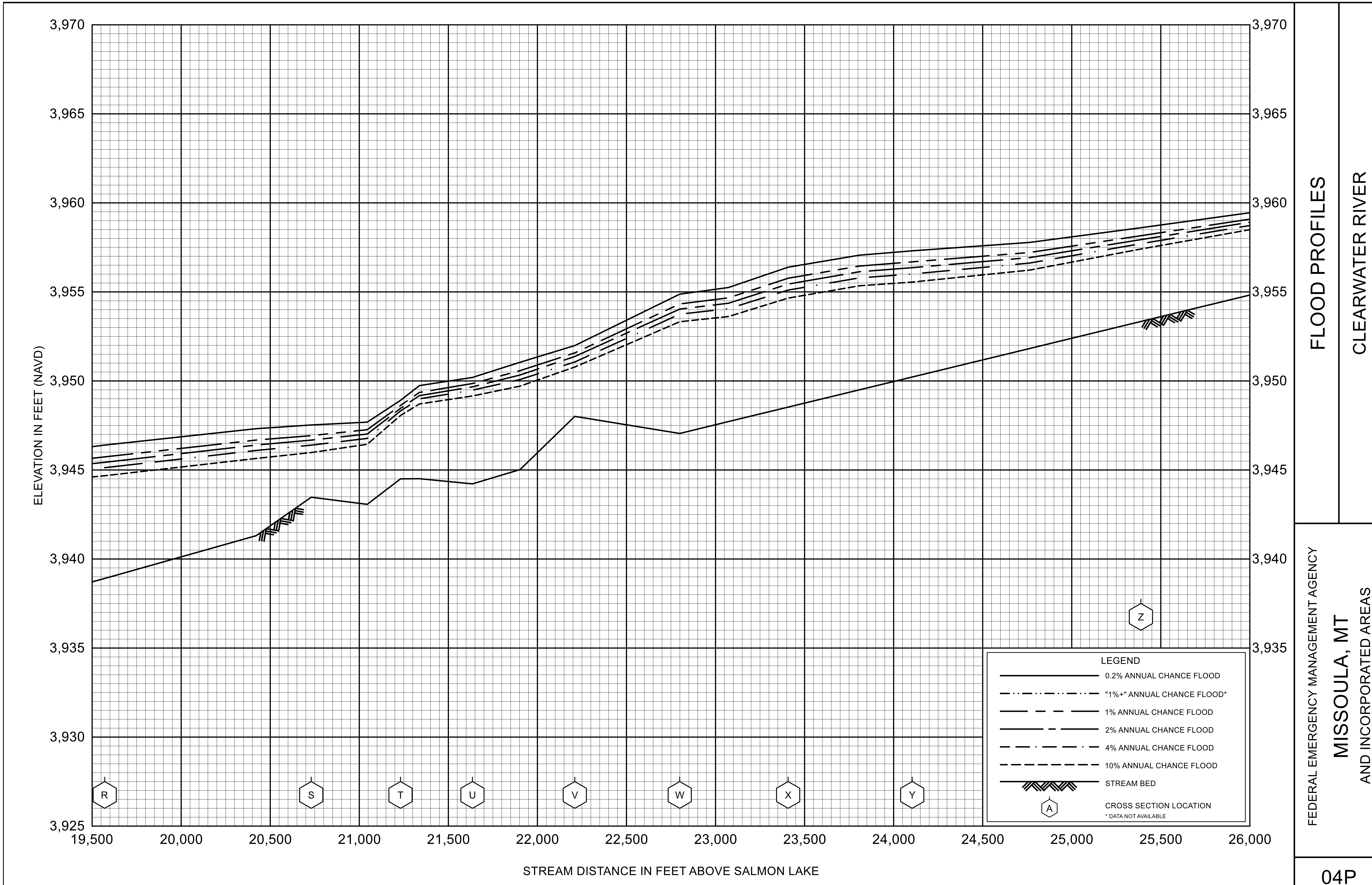
CLEARWATER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA, MT

AND INCORPORATED AREAS

03P



3,970
3,965
3,960
3,955
3,950
3,945
3,940
3,935
3,930
3,925
ELEVATION IN FEET (NAVD)
19,500
20,000
20,500
21,000
21,500
22,000
22,500
23,000
23,500
24,000
24,500
25,000
25,500
26,000
STREAM DISTANCE IN FEET ABOVE SALMON LAKE
R
S
T
U
V
W
X
Y
Z
LEGEND
0.2% ANNUAL CHANCE FLOOD
"1%+" ANNUAL CHANCE FLOOD*
1% ANNUAL CHANCE FLOOD
2% ANNUAL CHANCE FLOOD
4% ANNUAL CHANCE FLOOD
10% ANNUAL CHANCE FLOOD
STREAM BED
A
CROSS SECTION LOCATION
* DATA NOT AVAILABLE
FLOOD PROFILES
CLEARWATER RIVER
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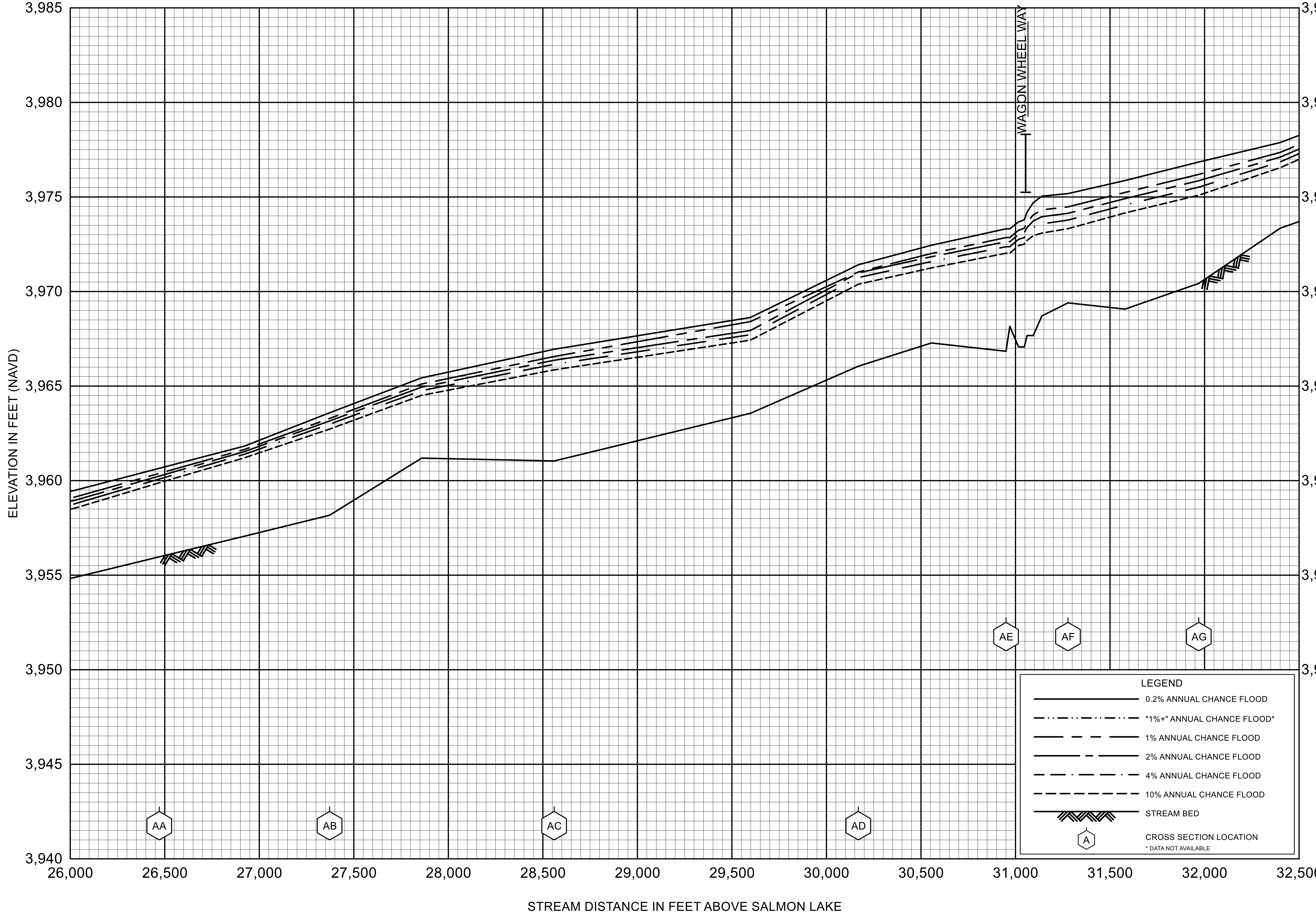
04P



FLOOD PROFILES

CLEARWATER RIVER

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MISSOULA, MT

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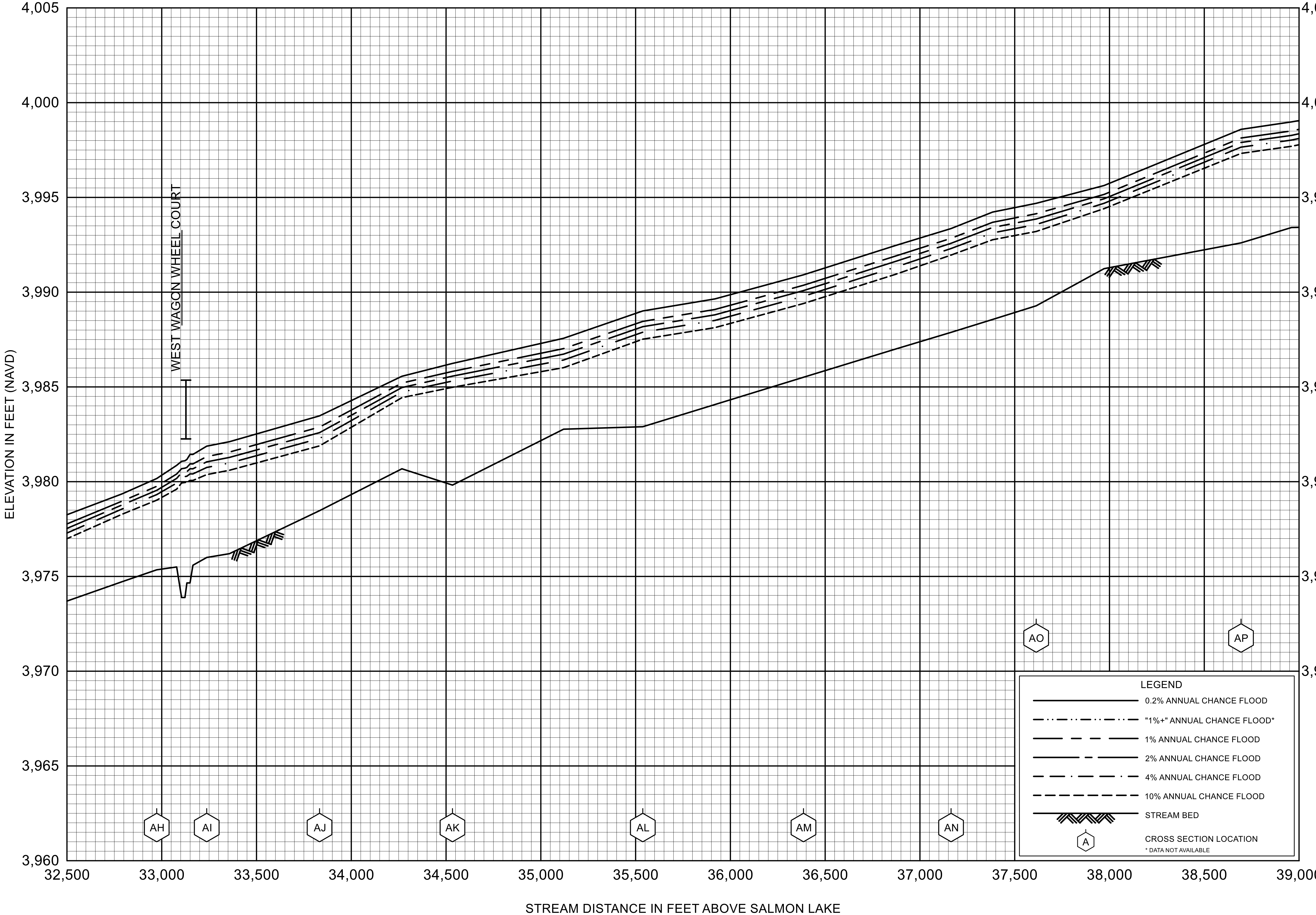

FLOOD PROFILES

CLEARWATER RIVER

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MISSOULA, MT

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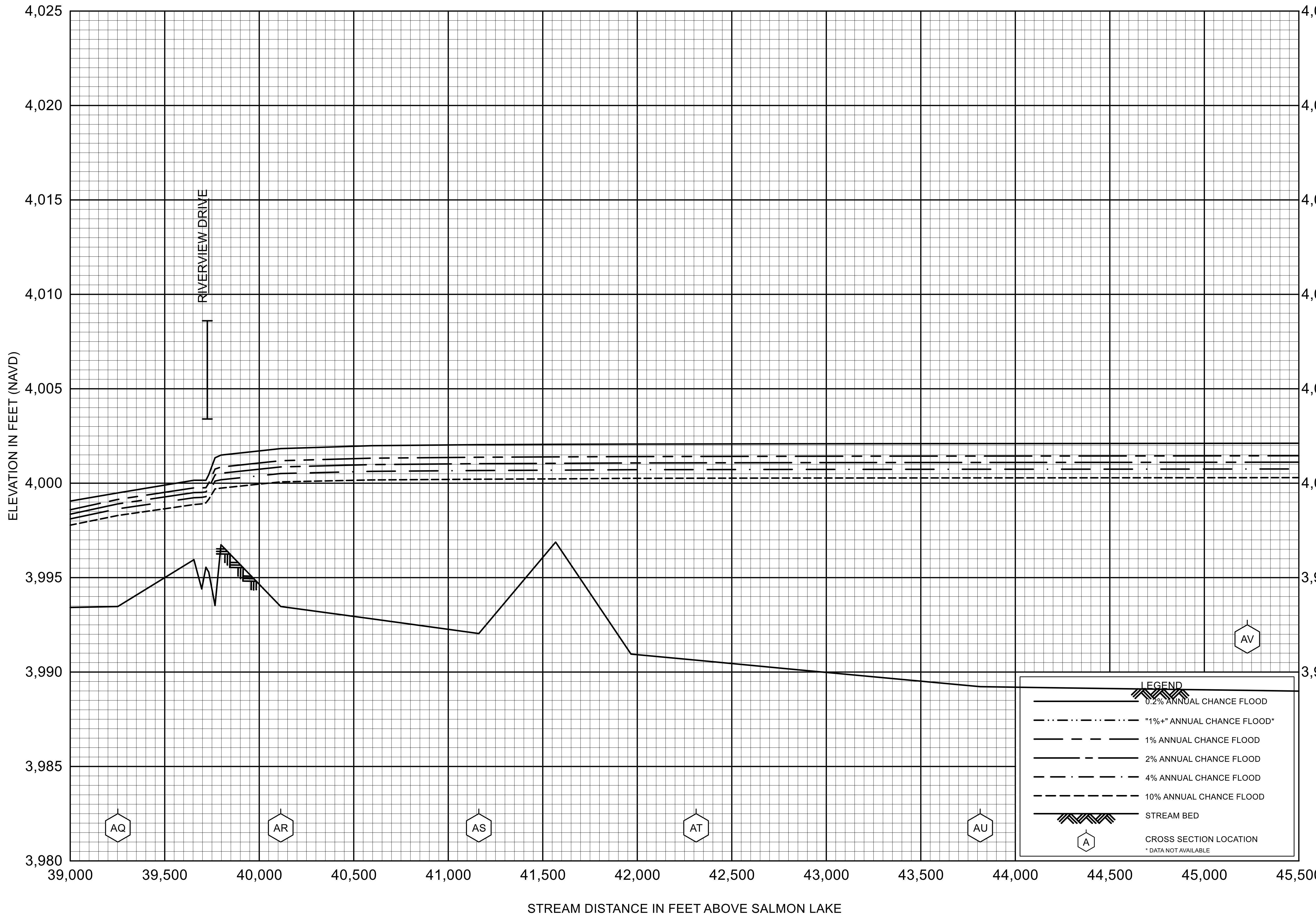


FLOOD PROFILES

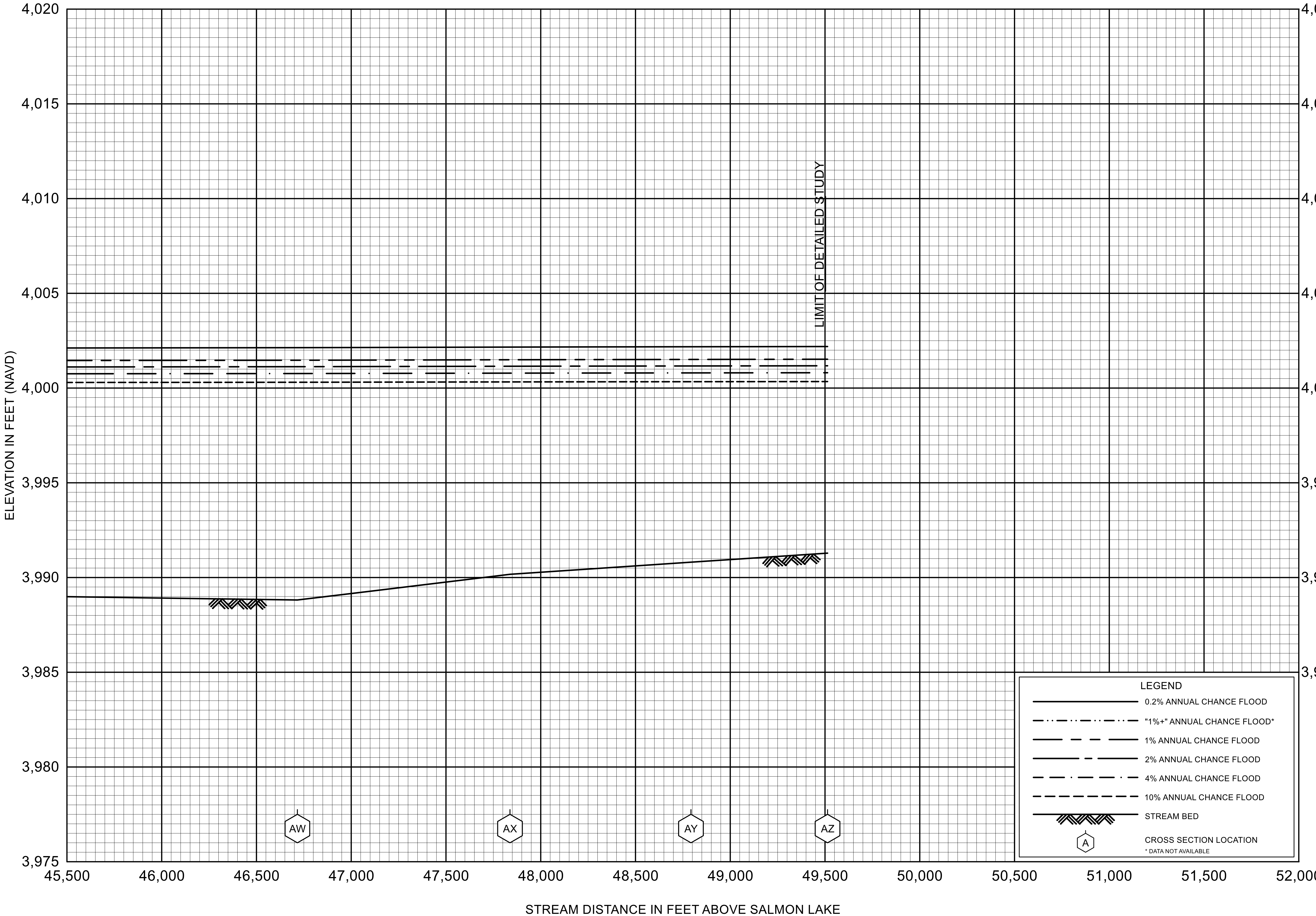
CLEARWATER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA, MT

AND INCORPORATED AREAS

07P



FLOOD PROFILES

CLEARWATER RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

MISSOULA, MT

AND INCORPORATED AREAS